CONNECTICUT RIVER FLOOD CONTROL PROJECT

LOCAL PROTECTION WORKS
HARTFORD, CONNECTICUT

ANALYSIS OF DESIGN
FOR
PARK RIVER CONDUIT

FISCAL YEAR 1939 SECTION, ITEM Ht-6

May 31, 1940

Corps of Engineers, U. S. Army

U. S. Engineer Office, Providence, R. I.

- - - - - -

Metcalf & Eddy
Engineers
Boston, Massachusetts

ANALYSIS OF DESIGN
FOR
PARK RIVER CONDUIT

FISCAL YEAR 1939 SECTION, ITEM Ht-6

INDEX

Page

HARTFORD PROTECTION WORKS
PARK RIVER CONDUIT

PERTINENT DATA

Location — Park River from its confluence with the Connecticut River to and across Bushnell Park, in the central portion of the City of Hartford, Conn.

Type of land protected -	Commercial and Industrial

Elevations (Above Mean Sea Level)

Inlet head wall (top)	51.0
Inlet dike (top)	50.0
Invert at inlet	15.25
Invert at outlet	-3.16

Concrete Conduit

Shape - Two compartments with common dividing wall; roof and floor cambered

Dimensions -

Height (interior)	19'-6"
Width (interior - each compartment)	30'-0"
Height (exterior)	
Heaviest section	26'-11"
Lightest section	22'- 7"
Width (exterior)	
Heaviest section	72'- 0"
Lightest section	66'- 6"
Total length, approximately	5,600 ft.

Inlet Structure

Type - concrete apron and cantilever wing walls, flanked on west by short low earth dike.

Maximum height of wall above apron	34 ft.
Length of apron	50 ft.

Outlet Structure

Type - concrete apron with cantilever wing walls; river bed beyond concrete protected by area of rock fill

Maximum height of wall above apron	26 ft.
Length of apron	84 ft.

Principal Quantities

Earth Excavation	204,000 c.y.
Rock Excavation	75,000 c.y.
Concrete	103,000 c.y.
Reinforcing Steel	16,000,000 lb.

I. INTRODUCTION

I. INTRODUCTION

A. AUTHORIZATION. - Flood protection work in the Park River is a part of the local protection works for the City of Hartford, Connecticut. The original project is included in the report on flood control for the Connecticut River and published as House Document No. 455, 75th Congress, Second Session. The project is authorized under the Flood Control Act approved June 28, 1938.

B. NECESSITY FOR THE PROTECTION. - Park River flows through the heart of the City of Hartford and enters the Connecticut River about 4000 ft. downstream from Memorial Bridge. It has a drainage area of about 78 square miles at its junction with the Connecticut River and is subject not only to backwater from Connecticut River but also to floods resulting from heavy rainfall on its own watershed. During the great flood of 1936, serious inundation of high value areas of the City of Hartford resulted from the backing of the Connecticut River into the low-lying valley of this stream. If the main Connecticut River dikes at Hartford, which have been or are about to be constructed, are to be effective, it is essential that the Park River be confined for that portion of its length subject to the effects of backwater from the Connecticut River.

C. TYPE OF PROTECTION WORKS FOR PARK RIVER. - The protection works for the Park River, as recommended by the Board of Engineers for Rivers and Harbors, was primarily designed for protection against backwater from Connecticut River floods as modified by the twenty reservoirs of the Comprehensive Plan. This requirement would have been satisfied by an open-walled channel consisting of cantilever or counterfort walls on both sides of the river from the Connecticut River upstream to Bushnell Park or Hudson Street; above this point a single wall following the left or north bank of the river to high ground near Asylum Street; and from Hudson Street to high ground along the southern edge of the Park an earth dike to prevent flood waters of the Park River from reaching the protected area.

Under this proposal a large area of Bushnell Park would be inundated during floods. For this and various other reasons the City of Hartford proposed a closed pressure conduit, beginning at the westerly edge of the park. This office agreed to design and construct the pressure conduit according to the requirements of the City, provided that the extra cost of this undertaking be paid for by the City. The project as discussed in this analysis, therefore, applies to the pressure conduit following the alignment as selected by the City. (For comparative costs see Section VI.) For general location plan and profile see Plates Nos. 1 to 7 inclusive.

D. <u>COOPERATION WITH REPRESENTATIVES OF THE CITY AND OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILROAD.</u> - During the preparation of preliminary layouts and estimates, and also during the actual design of the conduit, consultations have been held with the officials of the Hartford Flood Control Commission, of which Mr. Charles J. Bennett is Consulting Engineer and Executive Secretary, and with City Engineer Robert J. Ross, relative to the basic considerations and details in which they are interested. In its easterly portion the conduit has been kept below grades determined by the City for the future construction of a depressed traffic artery which may be built on top of the conduit. Through Bushnell Park the alignment of the conduit follows a location determined by the Flood Commission in consultation with the park authority of the City. They have been able to select a direct and economical route which would cause least damage to valuable shade trees and other features of the park. The design, as finally developed, meets the approval of the City of Hartford.

Where the New York, New Haven & Hartford Railroad track passes over the conduit just west of the dike, the structure has been designed to carry loads designated by the engineers of the railroad and the design has been reviewed and approved by them. The railroad was represented by Mr. E. E. Oviatt, Chief Engineer.

E. PROVISIONS FOR PUMPING FACILITIES. - The construction of the Riverfront Dike (under separate contract) and the Park River Conduit will prevent the natural surface drainage from reaching the Connecticut River during high river stages. For the purpose of discharging the accumulated surface drainage, including that from local storm runoff, from within the protected area and seepage through the dikes or their foundations, pumping facilities are necessary. Two pumping stations are proposed for the protected area, and, due to the characteristics of the existing sewer system, the two stations will be operated simultaneously. One station will discharge directly into the Connecticut River, while the other will be located in Bushnell Park near Hudson Street and will discharge into the proposed Park River Conduit. The pumping stations will be constructed under separate contracts, and discussion of their design will be found in the analysis for these stations.

A six-foot by six-foot opening will be provided in the Park River Conduit near Hudson Street for future connection with the pumping station outlet conduit. The surface drains along the conduit, which will be provided under this contract will be connected to the city sewer system, while the side drains will be connected independently to the Park River Conduit; see Section IV, B 4.

F. <u>SHORT DESCRIPTION OF THE PROPOSED WORKS.</u> - The pressure conduit will be about 5600 feet in length and will take the form of a double-barreled structure, each compartment having a clear width of 30 feet and a maximum clear height of 19.5 feet, with flatly curved roof and invert. It will begin at an outlet on the river face of the proposed Connecticut River dike and will follow in general the present course of Park River to Bushnell Park at Hudson Street; here it will leave the present course of the river and proceed by a more direct alignment across the Park, rejoining the existing river channel at the westerly side of the Park by means of a suitable intake structure about 1200 feet downstream from Broad Street.

II. GEOLOGICAL INVESTIGATION

II. GEOLOGICAL INVESTIGATION

A. FOUNDATION CONDITIONS

1. Subsurface conditions are shown on Plates Nos. 8 to 11 inclusive, entitled "Subsurface Explorations", and consist in general of fill and flood plain deposits of sand and silt overlying a layer of soft varved, red clay with natural void ratio of about 1.5. Below the clay and overlying rock is a compact formation of red, cohesive glacial till forming an excellent foundation stratum. For the greater part of its length the conduit rests directly on this glacial till or on rock. At the mouth of the conduit at the Connecticut River the compact till is from 20 to 45 feet below the foundation and in this section piles are used, driven through the clay and into the compact till.

2. Method and extent of explorations. - Numerous borings were made on and near the location of the proposed conduit. These borings determined the location of bedrock and also the nature of the overburden through which excavations must be made and on which in some instances the proposed structure will be constructed. The location of borings and a condensed record of the materials encountered will be found on the plates referred to above.

3. Site. - As described above under Paragraph I-F, the site of the proposed conduit follows the present location of the Park River channel except across Bushnell Park where a direct alignment cuts off the bend in the river course. For much of the distance in the channel red shale bedrock is close to the present bed of the stream, being covered only by a few feet of debris deposited by the stream. In its lower reaches, the bedrock falls away and is covered with a mantle of

sedimentary material of various grades including fine sand, silt and clay, which is an integral part of the deposits of these materials which occur in and along the Connecticut River in this vicinity. Along the course of the proposed conduit through Bushnell Park the foundation will be partly on bedrock and partly on glacial till which occurs in depressions in the rock surface.

4. Nature of excavations. - In the 1500 feet of length nearest the Connecticut River, excavation will be made in earth to a subgrade in the silty Connecticut River deposits referred to above, into which piles will be driven to reach the firm glacial till overlying bedrock at a probable maximum depth of about 45 feet below the subgrade. Above the firm glacial till lies a thick layer of varved clay, very weak and unstable and believed to be unsuitable, without piles, for the support of a structure of the importance and exposure of the proposed Park River conduit and its outlet.

In the next 2000 feet, or as far as Bushnell Park, the excavation will be in rock to depths substantially below the foundations of adjacent buildings which closely abut the river channel throughout this portion of the stream. This will require care in blasting and may possibly involve some underpinning.

Across Bushnell Park, excavation to reach subgrade in either rock or glacial till must pass through a substantial layer of varved clay, the treacherous characteristics of which will doubtless require the use of tight sheeting in making the excavation.

5. Borrow area. - For impervious backfill around the conduit under the Connecticut River front dike, material will be obtained from a

borrow area located approximately 6 miles from the outlet (see Plate No. 12). The material in this area consists of glacial till interstratified with silt, classes 11 and 13, with natural water content only slightly above that for optimum compaction. This area has been developed for previous use in embankment construction.

Pervious and impervious material for the dike near the inlet and for miscellaneous backfill may be obtained by selection from structure excavation.

B. LABORATORY INVESTIGATIONS

1. Classification of materials. - The Providence District has adopted a convenient system of soil classification having rigidly standardized terms. In this classification soils are divided into 16 classes as shown graphically on Plate No. 13 and described in Table No. 1. Soils of uniform grain size are designated by even numbers, soils of variable grain size by odd numbers and grain size limits of materials follow the M.I.T. Classification except that the size demarcation between silt and coarse clay is not 0.002 mm. but varies from 0.006 mm. to 0.0006 mm. Grain-size curves of samples were obtained by sieve and hydrometer tests run on representative samples for each stratum encountered in each exploration. These materials were classified and grouped into sedimentary units as shown on Plate No. 9 entitled "Underground Exploration".

2. Laboratory tests. - Water contents and void ratios were determined on 1-inch paraffined cores of the clay and silt. Undisturbed samples from the stratum of varved, soft clay have been secured and tested from ten 6-inch bore holes scattered throughout the Hartford Area. Extensive consolidation, direct shear, and unconfined compression tests have been run on these undisturbed samples and the results correlated to this project by comparison of Atterberg limits.

PROVIDENCE SOIL CLASSIFICATION
U. S. ENGINEER OFFICE
PROVIDENCE, R. I.
TABLE NO. 1

CLASS	DESCRIPTION OF MATERIAL
1	Graded from Gravel to Coarse Sand. - Contains little medium sand.
2	Coarse to Medium Sand. - Contains little gravel and fine sand.
3	Graded from Gravel to Medium Sand. - Contains little fine sand.
4	Medium to Fine Sand. - Contains little coarse sand and coarse silt.
5	Graded from Gravel to Fine Sand. - Contains little coarse silt.
6	Fine Sand to Coarse Silt. - Contains little medium sand and medium silt.
7	Graded from Gravel to Coarse Silt. - Contains little medium silt.
8	Coarse to Medium Silt. - Contains little fine sand and fine silt.
9	Graded from Gravel to Medium Silt. - Contains little fine silt.
10	Medium to Fine Silt. - Contains little coarse silt and coarse clay. Possesses behavior characteristics of silt.
10 C	Medium Silt to Coarse Clay. - Contains little coarse silt and medium clay. Possesses behavior characteristics of clay.
11	Graded from Gravel or Coarse Sand to Fine Silt. - Contains little coarse clay.
12	Fine Silt to Clay. - Contains little medium silt and fine clay (colloids). Possesses behavior characteristics of silt.
12 C	Clay. - Contains little silt. Possesses behavior characteristics of clay.
13	Graded from Coarse Sand to Clay. - Contains little fine clay (colloids). Possesses behavior characteristics of silt.
13 C	Clay. - Graded from sand to fine clay (colloids). Possesses behavior characteristics of clay.

III. FLOOD HYDRAULICS

III. FLOOD HYDRAULICS

A. DESIGN FLOODS. - The Park River flood on which the design of the conduit is based is the result of extensive studies made by the U. S. Engineer Office in Providence, R. I. and by the Engineers of the Hartford Flood Control Commission. These studies were reviewed by Metcalf & Eddy in their report dated January 19, 1940, in which the conclusion was reached that provision should be made for 18,000 cu. ft. per second in the Park River when the Connecticut River is at Elevation 26 and the headwater at the conduit inlet in Bushnell Park at Elevation 44. (See Appendix A.) This report has been accepted as the basis of design. The conduit as designed satisfies both the conditions established by the District Engineer and by the Engineers of the City.

B. FREEBOARD. - At the conduit inlet the headwall and other works provide a freeboard of 2 feet above the estimated maximum headwater level; wave action in this locality is expected to be negligible.

C. PUMPING REQUIREMENTS. - During large floods in the Connecticut River, the natural drainage and storm runoff from areas below the Park River conduit inlet and behind the Connecticut River dikes will have to be pumped from the protected area to the river. Pumping facilities to accomplish this will be provided in separate undertakings.

D. HYDRAULIC DESIGN.

1. Selection of Dimensions. - Considerations discussed in the report of Metcalf & Eddy dated February 23, 1940, upon Preliminary Layouts and Estimates led to the adoption of a double-barreled conduit of relatively wide and shallow proportions. Subsequent to that report, further comparative studies led to the final selection of 30 feet as the

inside width of each of the two compartments, and 19 ft. 6 in. as the maximum inside height. Both invert and crown are flat circular curves with middle ordinates of 2 ft. Small fillets at the top and bottom of exterior walls are provided for structural reasons. The cross-sectional area of each conduit is 544 sq. ft., a total of 1088 sq. ft., giving a velocity of 16.55 ft. per sec. at the design rate of 18,000 cu. ft. per sec. The same interior dimensions are used throughout the length of the conduit.

2. Hydraulic Losses. - The hydraulic computations were made on the basis of the following assumptions:

(a) Friction. - A roughness coefficient of n = 0.012 was used in the Manning formula, with additional allowance for curves.

(b) Curvature. - A radius of 150 ft. at the center line of the structure (mid-point of the dividing wall) was used for all curves. This brings the radii of the inner and outer conduits within the range where losses at curves in excess of those on tangents may be taken as

$0.25 \left(\frac{A}{90}\right)^{1/2} \frac{V^2}{2g}$ where A is the angle of deflection in degrees. intended to be 0.2 Δh_v Sug. 17 Jan 44

(c) Inlet. - A loss of 1.2 times the increment of velocity head was taken at the inlet. The water is guided smoothly into the inlet by parallel walls in the lower portion conforming to the old river channel and by cylindrical wing walls in the upper part. The crown of the inlet is rounded elliptically at the junction with the headwall.

(d) Outlet. - The velocity is assumed to be dissipated upon discharge into the Connecticut River, no attempt being made to recover head by special outlet design.

3. General Hydraulic Behavior. - Under the conditions assumed for maximum flow, the conduit will be submerged for its entire length and there are no velocity changes which require consideration except beyond the outlet where scour will be controlled by an apron of rock fill on the bed of the Connecticut River.

At moderate rates of flow in the Park River, when the conduit is less than full at its upper end, shooting velocities will obtain in the upper reaches of the conduit and an hydraulic jump will result. The location of the jump will depend upon the stage of the Connecticut and the rate of flow in the conduit. There are an infinite number of combinations of stage and rate of flow which might conceivably coincide, and at certain of these the jump would come in contact with the roof. The probability of coincidence of a critical river stage with a rate of flow in the conduit large enough to create a jump of troublesome proportions is extremely remote. The maximum capacity of the conduit would not be affected but the jump may possibly undulate causing vibration if in contact with the roof. It is believed that the structure is sufficiently massive to be undamaged by this infrequent eventuality.

An hydraulic model will be constructed to corroborate the design.

IV. STRUCTURAL DESIGN

IV. STRUCTURAL DESIGN

A. GENERAL. - The principal structure involved in this project is the double-barreled conduit of reinforced concrete. Special structures include inlet and outlet and certain incidental provisions for access and for connections with minor conduits.

1. Typical Conduit. - The double-barreled conduit is a statically indeterminate structure and has been designed as a rigid frame by a process of summation of increments of equal lengths. Several typical sections have been designed and for each locality that typical section is selected which best fits the conditions of loading.

2. Inlet Structure. - The inlet structure will consist of a cantilever headwall built integrally with the conduit roof, detached cylindrical cantilever wings and a concrete apron. The inlet is placed squarely across the existing river channel, the low vertical walls of which will be extended or rebuilt up to the inlet thus guiding ordinary flows smoothly into the mouth of the conduit. Floods which overtop the existing walls will encounter the cylindrical wing walls referred to above. A short low earth dike with concrete core wall is provided to complete the barrier between the inlet structure and the railroad retaining wall toward the west.

3. Outlet Structure. - The conduit passes through the earth dike at the Connecticut River on a skew and the typical section is cut off where the top of the conduit pierces the outer slope of the dike. A low parapet will retain the dike slope above the conduit roof and will serve (as will a similar member across the bottom of the conduit) as a beam to carry the loads resulting from the diagonal termination of the

conduit. Beyond this portal the channel is formed by parallel wings acting as cantilevers tied into the bottom slap or apron which forms an extension of the conduit bottom to its intersection with the face of the dike.

4. Access Manholes. - Access to each of the conduit compartments is provided at Main Street which is about midway of the conduit length through large storm water connections, the backwater gate manholes of which will be carried up above the hydraulic gradient.

5. Gully Brook Conduit. - Near its upper end, in Bushnell Park, two large openings are left in the northerly wall of the conduit each 7 foot wide and 9 feet high to permit the entrance of the Gully Brook conduit which is to be extended as a twin conduit across Bushnell Park and connected with the Park River conduit by the City. The conduit wall is reinforced to carry the loads interrupted by the openings. The Gully Brook conduit, as reconstructed, will be carried far enough back, as a pressure conduit, to prevent flooding.

6. Pumping Station Inlet. - Under a separate contract, a pumping station is to be built near Hudson Street at the easterly end of Bushnell Park to handle surface runoff in part of the protected area during high stages in the Connecticut River. An opening will be left in the northerly wall of the conduit at which a connection can be made for the discharge of water from the Bushnell Park pumping station into the conduit. This opening is locally reinforced.

7. Miscellaneous Openings. - Numerous openings suitably reinforced have been left in the conduit walls to permit the City to connect storm water sewers. In those cases where backwater during high water

could cause flooding through these sewers, suitable backwater gates will be provided situated in chambers outside the conduit structure.

B. SPECIFICATIONS FOR STRUCTURAL DESIGN.

1. General. - In general the structural design for the conduit has been executed in accordance with standard practice. In the following paragraphs are outlined the basic considerations which have been used in the structural design.

2. Unit Weights. - The following weights for materials were assumed in the design of the structures:

Water	62.5	lb. per cu. ft.
Dry earth	100.	" " " "
Saturated earth	125.	" " " "
Reinforced concrete	150.	" " " "

3. Earth Pressures. - In computing active earth pressures equivalent fluid pressures were used as follows:

Dry earth	35.	lb. per cu. ft.
Saturated earth	80.	" " " "

Passive resistance of earth was assumed to be equal to active earth pressure.

4. Hydrostatic Uplift. - The underside of structures was assumed to be subject to upward hydrostatic pressure equivalent to the full head of ground water above the plane of the foundation, distributed uniformly across the bottom. In general, ground water was assumed to stand at approximately the elevation of the tops of nearby existing sewers on the theory that, after the Connecticut River dikes with their sheet pile cutoff are built, infiltration into the existing sewers will govern the ground water level in Hartford. In certain of the conduit sections the ground water level must be further lowered to avoid flotation.

This will be done by the use of side drains carried to outlets into the conduit east of Commerce Street and near Hudson Street, gated to prevent backflow when either of the rivers is up. These drains will not be connected to the City sewer system. When the conduit is full there is no net uplift and a higher ground water will not offset the stability of the structure.

5. Bursting Pressure. - When the Connecticut River is in flood, the Park River conduit will be subject to bursting pressure. For the purposes of design, the Connecticut River has been assumed to stand at Elevation 42 (maximum determined by Hartford engineers).

6. Bearing. - Unit loads on rock foundations are much less than customary permissible loads on rock. Where foundations are on glacial till through portions of Bushnell Park, unit bearing loads do not exceed 3500 lb. per sq. ft. which is believed to be conservative for this material. Between the Connecticut River and the point east of Front Street where rock foundation commences, the conduit will be carried on piles through the underlying thick layer of unstable varved clay to the dense glacial till overlying bedrock. East of Commerce Street where conduit loads are heaviest, concrete piles are called for, designed and spaced to carry 50 tons each. Elsewhere timber piles, carrying 16 tons will be used, since the spacing of the stronger concrete piles under the lighter conduit sections would be too great. These piles will be always below ground water level.

7. Frost Cover. - Frost cover does not enter into this problem except at the approach walls of the inlet structure which will be carried down so as to provide at least 4 ft. of depth below ground surface unless

ledge is encountered at a higher elevation.

8. Reinforced Concrete.

a. General Practice. - The design of the reinforced concrete is in general in accordance with the recommendations of the joint committee and the American Concrete Institute.

b. Allowable Stresses.

(1) Ultimate Strength. - Ultimate compressive strength of concrete is assumed to be an average of 3400 lb. per sq. in. in 28 days with minimum not less than 2500 lb. per sq. in.

(2) Working Allowances. - The following working stresses have been used:

	lb. per sq. in.
Compression in concrete	900
Tension in steel	18,000
Shear without web reinforcement and without special anchorage	50
Shear with web reinforcement and without special anchorage	150
Bond deformed bars	125
Laps or embedment to develop bond, at least 45 diameters	

The ratio of moduli of elasticity was taken as 12. At least 4 inches of concrete is provided over steel in the lower face of footing and 3 inches against forms.

(3) Temperature Steel in exposed faces was provided at least equivalent to 5/8-inch round bars 12 inches on centers.

9. Reinforcing Steel. - The steel assumed to be used is new billet steel, intermediate grade, deformed bars.

C. LOADINGS. - The structures were designed to resist the most unfavorable combination of loadings which are likely to occur simultaneously.

1. External Loads. - When there is little or no water flowing in the Park River the conduit must resist external loads from the refill over the top plus highway loads where applicable; horizontal earth pressures against the outside walls; and upward hydrostatic pressures on the foundation. The foregoing may be considered as the usual condition.

Under the railroad track just east of the dike, the conduit is capable of carrying Cooper's E - 60 (equivalent uniform load) on either one or both conduits. Where highway loads may reach the conduit, the uniform equivalent of H-20 loading was used.

If the time shall come when the shallow fill between Commerce and Main Streets is removed and a paved roadway constructed close to the top of the conduit, a temporary condition may exist where the earth load has been removed from one-half of the conduit for construction purposes while the other half is still loaded with the original earth fill plus some construction equipment. Consideration was given to this extraordinary condition of unsymmetrical loading, and the design considered acceptable if the resulting unit stresses did not unreasonably exceed usual values in view of the transient character of this loading.

2. Internal Loads. - The interior of the conduit is subject to bursting pressure from flood levels in the Connecticut River which back into the conduit. Stresses due to bursting in combination with other conditions are permitted to exceed usual values by reasonable amounts, owing to the rarity of extreme floods in the Connecticut River.

D. ARCHITECTURAL TREATMENT OF EXPOSED SURFACES.

1. Inlet. - For hydraulic reasons, the exposed surfaces of head and wing walls at the inlet will be of smooth concrete. This

structure lies at the extreme limits of Bushnell Park, adjacent to the barren parade ground in the rear of the State Armory and the expense of cut stone finish is not believed justified even if permissible under hydraulic considerations.

2. Outlet. - The exposed surfaces of head wall and wings at the outlet structure will be plain, smooth concrete surfaces. The surfaces of this structure are not seen except from the river and there is no occasion for special architectural treatment.

V. CONSTRUCTION PROCEDURE

V. CONSTRUCTION PROCEDURE

A. SEQUENCE OF OPERATIONS. - It is probable that operations will be started first at and near the outlet and later at the easterly end of Bushnell Park, and that work will progress westerly from each of these points. From the outlet to Hudson Street, the work will be subject to discontinuance during the high water season, and to occasional interruption during the construction season by intermittent high water in the Connecticut River and by floods in the Park River itself. The upper section through Bushnell Park, except at its extremities, will be comparatively independent of ordinary floods in either river and work can be continued there throughout the year subject only to such limitations as are imposed by winter weather.

1. Downstream Section. - The first work in the section from the outlet to Hudson Street will include the construction of the outlet and the heavy conduit section across Dutch Point beneath the site of the dike and the railroad tracks. At the outset, this will involve construction of cofferdams to exclude the Connecticut River on the east side and the Park River on the west side of Dutch Point. The elevation selected for the tops of these dams should be such as to prevent too frequent overtopping by high water in the Connecticut River. In this locality, also, traffic over the single main line railroad track and access by roadway to the Dutch Point power plant must be maintained. It is of primary importance that the work be carried far enough to permit the diversion of Park River across Dutch Point in the latter part of 1940 in order to permit the filling of the present mouth of Park River, by another contractor at the earliest possible moment.

For the construction of the conduit in the present bed of Park River it will probably be necessary to enclose a section several hundred feet in length between two temporary dams of sandbags or other type carried completely across the river channel, the flow of Park River being conveyed between the two dams through a large pipe or enclosed flume. This pipe would probably be erected at one side of the channel while something over half the width of the bottom is constructed on the other side, after which the pipe would be moved over to permit the completion of the bottom. In its second location, the pipe would be placed so as not to interfere with the construction of walls and roof of the conduit. The height of the temporary dams would be such as to prevent the backing in of the Connecticut downstream, or too frequent overtopping by high flows in the Park River, upstream; and the flume would be proportioned to suit a rate of flow which will not be exceeded too often during the construction season.

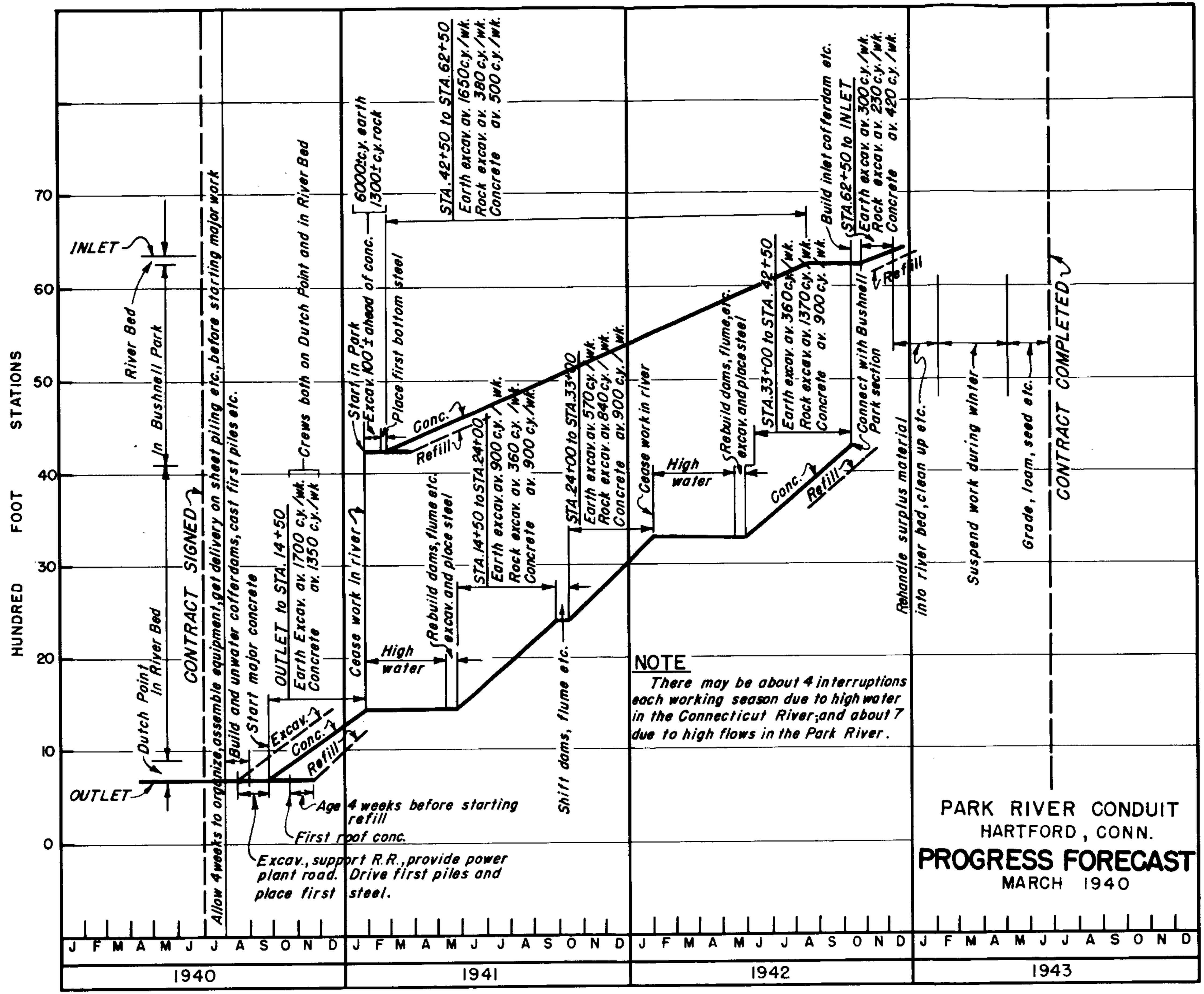
After the completion of the conduit in a given section, temporary dams and flume would be removed and moved to a new section upstream. The finished conduit would then be used to convey the water below the working section, the lower temporary dam being built within the conduit to exclude backwater from the Connecticut River.

2. Upper Section. - West of the point where the conduit leaves the bed of Park River and passes through Bushnell Park, construction will be comparatively free from interference by ordinary high water in the Park River, except at the inlet end and at the point near Hudson Street where connection is made with the lower section. The work through Bushnell Park involves deep and wide excavation in both earth and rock.

Much of the excavated material will probably have to be placed in storage piles until it can be ultimately disposed of in the present bed of the Park River after the completion of the conduit. A limited amount can be used in refilling portions of the finished structure after the concrete has aged sufficiently to carry the load. It may also develop that considerable quantities of excavated material can be hauled directly and dumped in designated parts of the Park River channel near Dutch Point after the lower end of the conduit and the outlet structure are completed and can be used to carry the discharge of Park River.

Construction work through Bushnell Park can presumably be done through the entire year, making it possible for the contractor to maintain his organization during the late winter and spring season when work in the river bed is impossible owing to high water. Progress in this section may be restricted due to the large volume of excavation and the probable necessity for tight sheeting. The latter will be required on account of the treacherous character of the soft clay which constitutes a large portion of the earth excavation and also because of the limitation in width imposed by the necessity for minimizing the damage to trees and other park features.

B. PROGRESS SCHEDULE. - The diagram on the following page indicates a tentative forecast of progress. It assumes the award of a construction contract on July 1, 1940, but can be readily adjusted for other starting dates. The full line of the diagram designates finished concrete on the assumption that excavation, refill, etc. will, in general, be paced to permit maximum progress in the concrete item. Considering the type of the project, the difficulty of access to some parts of the



PARK RIVER CONDUIT
HARTFORD, CONN.
PROGRESS FORECAST
MARCH 1940
HUNDRED FOOT STATIONS
0
10
20
30
40
50
60
70
INLET
OUTLET
River Bed In Bushnell Park
Dutch Point In River Bed
CONTRACT SIGNED
Allow 4 weeks to organize, assemble equipment, get delivery on sheet piling etc., before starting major work
Build and unwater cofferdams, cast first piles etc.
Start major concrete
Excav.
Conc.
Refill
Excav., support R.R., provide power plant road. Drive first piles and place first steel.
First roof conc.
Age 4 weeks before starting refill
OUTLET to STA. 14+50
Earth Excav. av. 1700 c.y./wk.
Concrete av. 1350 c.y./wk.
Crews both on Dutch Point and in River Bed
Cease work in river
High water
Rebuild dams, flume etc. excav. and place steel
STA. 14+50 to STA. 24+00
Earth excav. av. 900 c.y./wk.
Rock excav. av. 360 c.y./wk.
Concrete av. 900 c.y./wk.
Shift dams, flume etc.
STA. 24+00 to STA. 33+00
Earth excav. av. 570 c.y./wk.
Rock excav. av. 840 c.y./wk.
Concrete av. 900 c.y./wk.
Cease work in river
High water
Rebuild dams, flume, etc. excav. and place steel
STA. 33+00 to STA. 42+50
Earth excav. av. 360 c.y./wk.
Rock excav. av. 1370 c.y./wk.
Concrete av. 900 c.y./wk.
Conc.
Refill
Connect with Bushnell Park section
Start in Park
Excav. 100'± ahead of conc.
Place first bottom steel
6000± c.y. earth
1300± c.y. rock
Conc.
Refill
STA. 42+50 to STA. 62+50
Earth excav. av. 1650 c.y./wk.
Rock excav. av. 380 c.y./wk.
Concrete av. 500 c.y./wk.
Build inlet cofferdam etc.
STA. 62+50 to INLET
Earth excav. av. 300 c.y./wk.
Rock excav. av. 230 c.y./wk.
Concrete av. 420 c.y./wk.
Refill
Rehandle surplus material into river bed, clean up etc.
Suspend work during winter
Grade, loam, seed etc.
CONTRACT COMPLETED
NOTE
There may be about 4 interruptions each working season due to high water in the Connecticut River; and about 7 due to high flows in the Park River.
J F M A M J J A S O N D
1940
1941
1942
1943

site and the nature of conditions under which work must be done, it seems probable that the rate of concreting will not average more than 150 cubic yards per day taking into consideration occasional days when none can be done. In the heavy section east of Commerce Street this rate can perhaps be exceeded, owing to the massive character of the structures in this locality.

Work in the section between the Connecticut River and Hudson Street is necessarily interrupted during the high water season in the Connecticut River. In the diagram, this is assumed to be from the first of February to the middle of May.

In the diagram it is assumed that work in Bushnell Park will not be started until the beginning of the first high water season. The organization developed at Dutch Point and in the lower reaches of Park River will then be transferred to Bushnell Park where work will thereafter continue uninterrupted for about two years, being finished at about the same time that the upper end of the river section joins the lower end of the park section. The inlet will be built last, after the entire conduit is available to take the river flow diverted from the old channel.

It appears that the work will consume at least three complete seasons, and it is anticipated that all work will be completed by July 1, 1943.

C. CONSTRUCTION DETAILS.

1. Cofferdams. - The river bottom in the general location of the cofferdam required in the Connecticut River for the construction of the Park River Conduit outlet is at approximately Elevation-13. It

seems probable that the contractor will elect to carry the cofferdam at least up to Elevation 10 in order to protect his works from water level in the Connecticut River up to Elevation 8 or 9. From data supplied by the U. S. Weather Bureau for the period from 1917 to 1938 (see Plates Nos. 14 and 15) it appears that the water level in the Connecticut River may be expected to exceed Elevation 8 on the average of about 4 times during the construction season, which is assumed to be from the middle of May until the first of the following February. If the cofferdam were raised to exclude all river levels below Elevation 10 it would be overtopped about three times on the average during the construction season. This cofferdam will presumably be constructed of cells or of two lines of sheet steel piling properly tied together and filled with earth. The sheet piling should probably extend approximately to Elevation-30 in order to penetrate about 10 feet into the impervious material indicated by the borings to prevent underflow.

Any cofferdams in the Park River east of Front Street may also be constructed of sheet piling but at and above Front Street there is insufficient overburden above the bed rock for the penetration of sheeting so that dams of sandbags or similar construction will probably be required. The downstream dam of any section to be unwatered for construction in the bed of the Park River will be at substantially the same elevation as that adopted for the Connecticut River cofferdam. The upstream dam must be high enough not only to exclude water which backs in from the Connecticut River through the flume, but also to divert the flow of Park River into the flume.

Records of maximum rates of flow in the Park River from 1937 to 1939 inclusive indicate that during the proposed construction season rates of flow in excess of 400 cubic feet per second may be expected to occur 7 times and in excess of 600 cubic feet per second, 5 times. It would appear that the flume must have adequate capacity to carry flows of this order of magnitude if the works are not to be drowned out at frequent intervals.

2. Railroad Crossing. - A single main track of the Valley Branch of the New York, New Haven & Hartford Railroad must be maintained where the railroad crosses the site of the conduit near its lower end. It is probable that spur track service to the Dutch Point power plant can be temporarily provided south of the limits of the work. Alternate methods for providing for this railroad track would be: (1) carry the track over the work on a temporary bridge spanning the excavation; or (2) shift the track to one side, possibly using the approximate location of one of the existing sidings, while a section of the conduit is constructed and aged sufficiently to carry loads; then shift the track back to its final location on the fill over the conduit and continue the construction.

3. Street Crossings. - Existing highway bridges at Commerce Street, Front Street, Prospect Street and Hudson Street must be removed to permit the construction of the conduit. This will be done by the contractor just prior to his occupation of each location.

As soon as possible after the construction of the conduit beneath any bridge, the street will be restored to service by the construction of a temporary or permanent bridge to be built by the city.

Not more than one of these cross streets may be out of service at any one time. The existing bridge at Main Street will not be removed since it has sufficient clearance to permit the conduit to pass through without interference. The contractor will be permitted to utilize the stub ends of the closed streets for construction purposes to such an extent as will not unduly interfere with access to private property by the occupants thereof.

In Bushnell Park the conduit intersects Trinity Street, and, near the westerly end, the Park roadway. Trinity Street is an important thoroughfare and must be kept in service with a minimum of interruption. For this reason, the cut and cover method should be used at the Trinity Street crossing providing a plank floor overpass for traffic while construction is going on beneath.

At the Park roadway there is but little clearance between the road surface and the top of the conduit roof. Cut and cover is therefore impracticable at this street and traffic will be detoured during construction at this point.

4. Piles. - Both concrete and timber piles will be used as discussed in Paragraph IV-B-6. If the concrete piles are of the precast type, casting should commence as soon after the contract is signed as the contractor can get accurate information as to the required length of the first piles to be driven. These piles will then be suitably aged by the time the cofferdam has been unwatered and excavation made to subgrade.

Piles pass through a considerable stratum of weak and unstable silty clay. The disturbance of this material may make necessary special precautions to avoid injury to the foundations of nearby buildings particularly that of the Dutch Point power plant. Careful observation should be made during construction to determine whether special precautions are necessary, such as a temporary sheet pile curtain driven through the unstable material between the work and the critical nearby structure or holes can be sunk in advance of the piles to compensate for the displacement of material.

At certain cross streets, the bridges of which must be removed to permit the construction of the conduit, new bridges will subsequently be built by the State Highway Department, who have asked that steel H piles be driven under this contract for use under future abutments. This has been provided for.

5. Rock Fill and Riprap. - The protective apron of dumped rock in the bed of the Connecticut River at the Park River conduit outlet should be placed as soon as possible after the outlet is constructed in order to protect against scour resulting from the early diversion of the Park River into completed portions of the conduit. The slopes of the river channel at and immediately above the conduit inlet will be protected by riprap.

6. Drainage Systems. - Certain sections of the Park River conduit will be buoyant when empty if water is allowed to rise too high outside the structure. For this reason side drains are provided where necessary to prevent the undue rise of the ground water elevation adjacent to the conduit. Surface water drains are provided at each side of the conduit where needed, discharging into the existing Connecticut River interceptor just east of Commerce Street and near Hudson Street.

7. Sewers. - Existing sewers must be reconstructed where

they cross the site of the conduit as follows:

a. Park River interceptor near the inlet is to be rebuilt as an inverted siphon, passing beneath the conduit. The upstream manhole of this siphon is provided with gates to prevent the flow of flood waters from the Park River through this sewer into the city, and to admit the contents of this sewer directly into the conduit during floods.

b. Hudson Street Sewer will be rebuilt as an inverted siphon and the necessary approach changes will be carried out by the city.

c. Connecticut River interceptor, which now passes under the present river bed as an inverted siphon, will be lowered to pass under the conduit, the approaches being revised as necessary by the City.

The contents of these sewers must be provided for during construction as a part of the problem of handling stream flow.

D. TESTING MATERIALS.

1. Soil. - Any soil tests required to determine the adequacy of foundation material encountered will be made at the soil laboratory of the U. S. Engineer Office at Providence, R. I. or in the field soil laboratory at Hartford, Connecticut.

2. Concrete Construction. - Materials used in the making of concrete will be tested at the Central Concrete Laboratory, West Point, New York. Field tests will principally be used for control of quality of concrete during construction. Facilities will be available for grading the aggregate, designing mixes, making of slump tests and for casting and curing concrete cylinders for compression tests.

Cement will be tested by the Central Concrete Laboratory and results of these tests will be known before the cement is used.

Fine and coarse aggregates will be obtained from approved commercial sources. Storage of cement and aggregate, mixing and placing of concrete and placing of reinforcement steel will be supervised and directed by Government inspectors.

VI. SUMMARY OF COST

VI. SUMMARY OF COSTS

A. The total construction cost of the Park River conduit, Item Ht-6, of the Hartford flood protection works, has been estimated at $3,711,400, including 10% for contingencies and 15% for engineering and overhead, but excluding the cost of land, rights of way, and certain necessary landscape work which the city will do in Bushnell Park. This figure has been distributed as follows:

1.	Preparation and excavation	$ 657,600
2.	Piling	247,400
3.	Concrete structures	2,605,000
4.	Backfill and surfacing	128,300
5.	Sewers, drains and miscellaneous	73,100
	Total	$3,711,400

1. The preparation and excavation item includes preparation of the site, control of water and sewage, removal of structures and excavation.

2. The piling item includes concrete, wood and steel piles, and sheet steel piling.

3. The concrete structures item covers all concrete structures for the conduit, inlet and outlet, and appurtenant structures, including steel reinforcement, copper water stops and expansion joints.

4. The backfill item includes backfill, riprap, rockfill, gravel and graded stone, topsoil, grassing and paving.

5. The item for sewers, drains, and miscellaneous includes the pipe, manholes, catch-basins, gates, etc. for side and surface drains and for sewer reconstruction, all metal work and other items not covered in Items 1 to 4, inclusive, above.

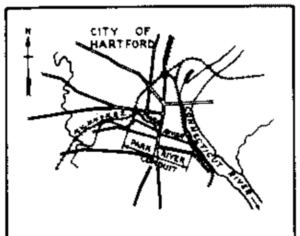
B. The Federal Government's share of the cost as indicated by the estimated cost of the open channel plan (see Section I - C), is $2,764,600. This is subject to adjustment in the light of actual bid prices. On the basis of this estimate the share to be assumed by the City of Hartford would be $946,800.

VII. INDEX OF PLATES

VII. INDEX OF PLATES

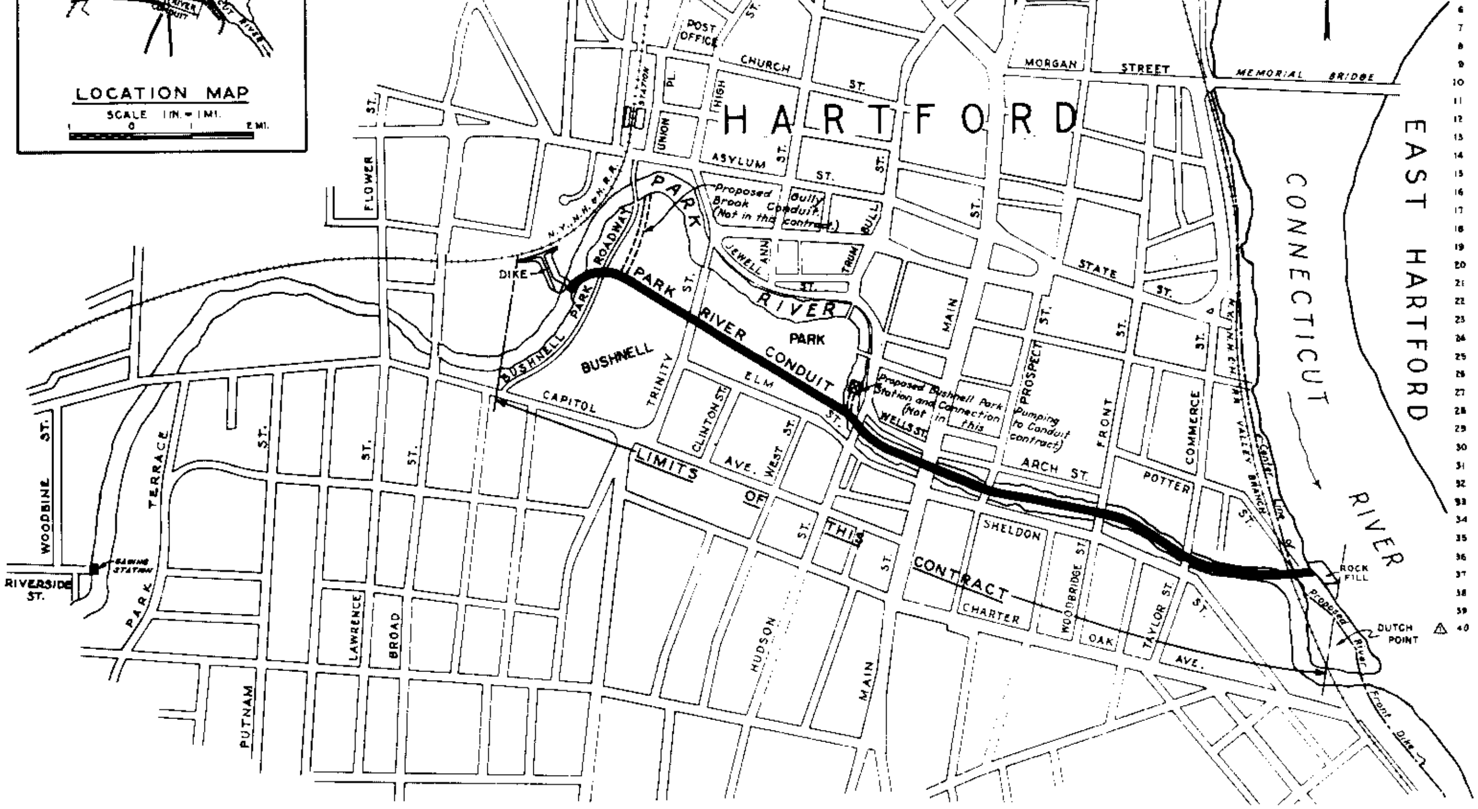
WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



LOCATION MAP

SCALE 1 IN. = 1 MI.



VICINITY MAP

SCALE 1 IN. = 400 FT.

INDEX TO DRAWINGS

SHEET NO.	DESCRIPTION	FILE NO.
1	PROJECT LOCATION AND INDEX	CT-4-2606
2	HYDROGRAPH NO. 1, CONNECTICUT RIVER	CT-3-1174
3	HYDROGRAPH NO. 2, CONNECTICUT RIVER	CT-3-1175
4	HYDROGRAPH PARK RIVER	CT-3-1173
5	SUBSURFACE EXPLORATIONS NO. 1	CT-2-1286
6	SUBSURFACE EXPLORATIONS NO. 2	CT-2-1287
7	SUBSURFACE EXPLORATIONS NO. 3	CT-2-1288
8	SUBSURFACE EXPLORATIONS NO. 4	CT-2-1289
9	CONTRACTOR'S WORK AREAS	CT-4-2607
10	PLAN AND PROFILE NO. 1	CT-4-2608
11	PLAN AND PROFILE NO. 2	CT-4-2609
12	PLAN AND PROFILE NO. 3	CT-4-2610
13	PLAN AND PROFILE NO. 4	CT-4-2611
14	PLAN AND PROFILE NO. 5	CT-4-2612
15	PLAN AND PROFILE NO. 6	CT-4-2613
16	CONDUIT SECTIONS NO. 1	CT-4-2614
17	CONDUIT SECTIONS NO. 2	CT-4-2615
18	PILING NO. 1	CT-4-2616
19	PILING NO. 2	CT-4-2617
20	PARK RIVER INTERCEPTOR SIPHON DETAILS NO. 1	CT-4-2618
21	PARK RIVER INTERCEPTOR SIPHON DETAILS NO. 2	CT-4-2619
22	SIPHON INLET CHAMBER DETAILS	CT-4-2620
23	SIPHON INLET CHAMBER STEEL REINFORCEMENT	CT-4-2621
24	SIPHON OUTLET CHAMBER DETAILS	CT-4-2622
25	SIPHON OUTLET CHAMBER STEEL REINFORCEMENT	CT-4-2623
26	INLET STRUCTURE WALLS	CT-4-2624
27	INLET STRUCTURE WALL REINFORCEMENT NO. 1	CT-4-2625
28	INLET STRUCTURE WALL ELEVATIONS	CT-4-2626
29	MISCELLANEOUS INLET DETAILS	CT-4-2627
30	OUTLET STRUCTURE DETAILS NO. 1	CT-4-2628
31	OUTLET STRUCTURE DETAILS NO. 2	CT-4-2629
32	OUTLET STRUCTURE STEEL REINFORCEMENT NO. 1	CT-4-2630
33	OUTLET STRUCTURE STEEL REINFORCEMENT NO. 2	CT-4-2631
34	CONNECTICUT RIVER INTERCEPTOR AND HUDSON ST. SIPHONS	CT-4-2632
35	DRAIN CHAMBERS	CT-4-2633
36	DRAIN MANHOLES AND CATCHBASINS	CT-4-2634
37	SEWER CONNECTIONS NO. 1	CT-4-2635
38	SEWER CONNECTIONS NO. 2	CT-4-2636
39	MISCELLANEOUS DETAILS	CT-4-2637
△ 40	TEMPORARY WATER LINE TO THE DUTCH POINT LIGHTING PLANT	CT-4-2706

KEY	DATE	REVISION (indicated by △)	REV BY	CK. BY	AP BY
△	10-7-40	Sheet No. 40 added			

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

PROJECT LOCATION AND INDEX

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE 1 IN. = 400 FT. — SHEET NO. 1

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

REVIEWED: N. W. Hansen, ENGINEER, F.C. DESIGN SECTION
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF F.C. ENGINEERING DIV.
APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

SUBMITTED: (PARTNER) METCALF & EDDY, BOSTON, MASS.

DRAWN BY E.S.G.
TRACED BY E.S.G. M.C.T.
CHECKED BY R.W.T.

FILE NO. CT-4-2606

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PLATE NO. 1

H+6

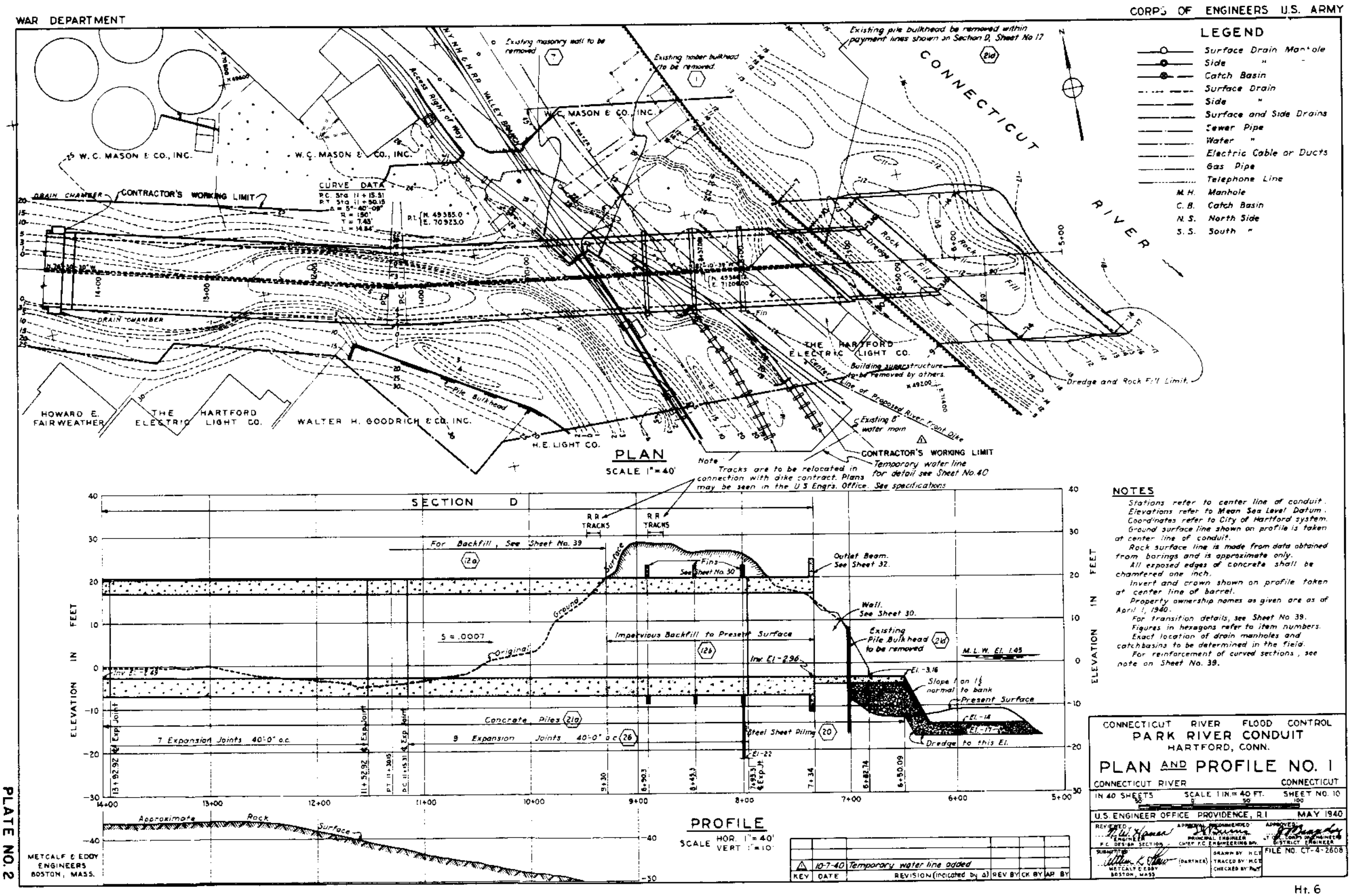
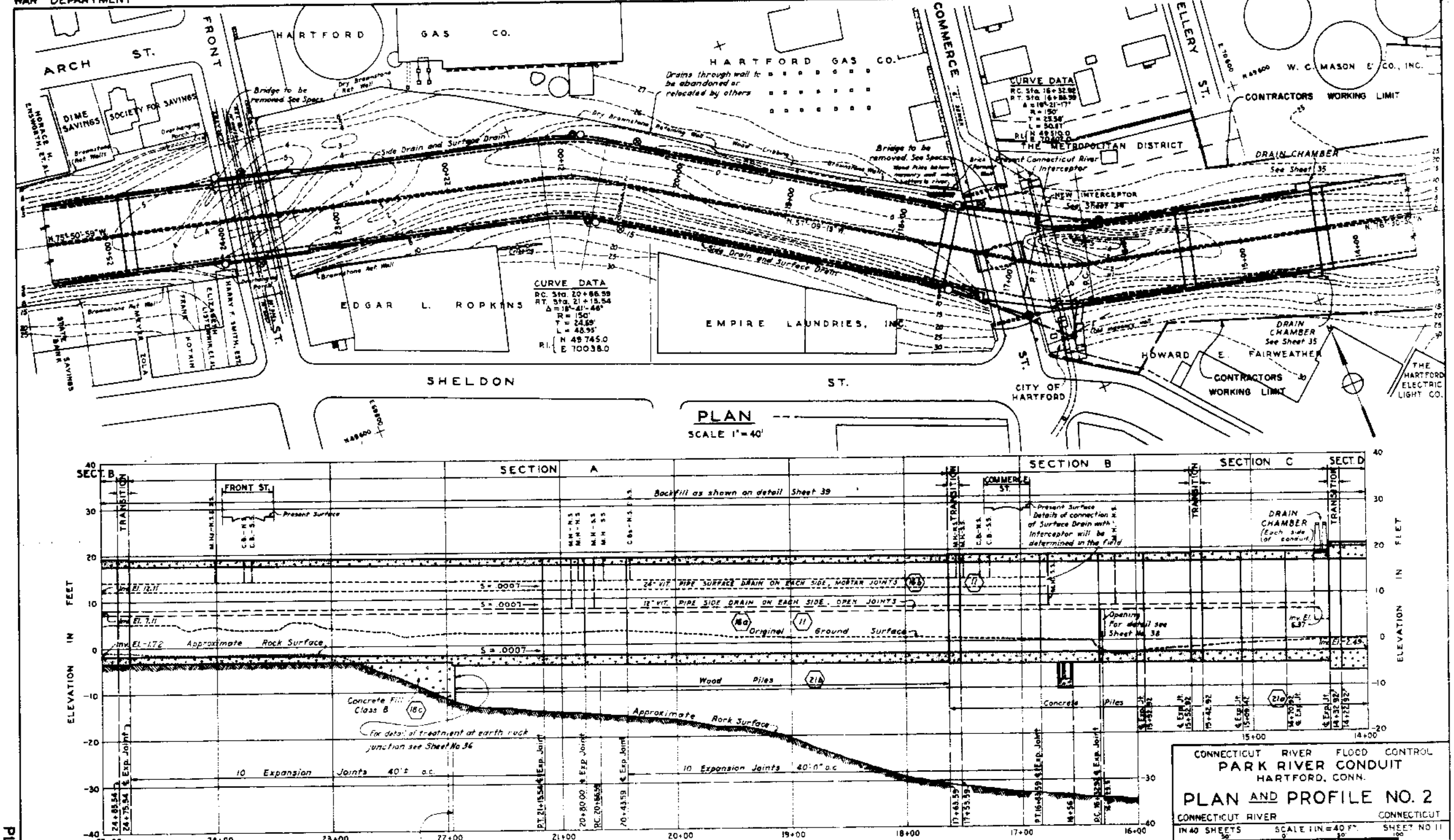


PLATE NO. 2

Ht. 6

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



NOTES

For general notes applying to details shown on this sheet, see Sheet No. 10.

See legend on Sheet No. 10.

For Contractor's working limit above Commerce St. see Sheet No. 9

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

PLAN AND PROFILE NO. 2

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE 1 IN. = 40 FT. — SHEET NO. 11

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

REVIEWED: ENGINEER, F.C. DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF F.C. ENGINEERING DIV. — APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

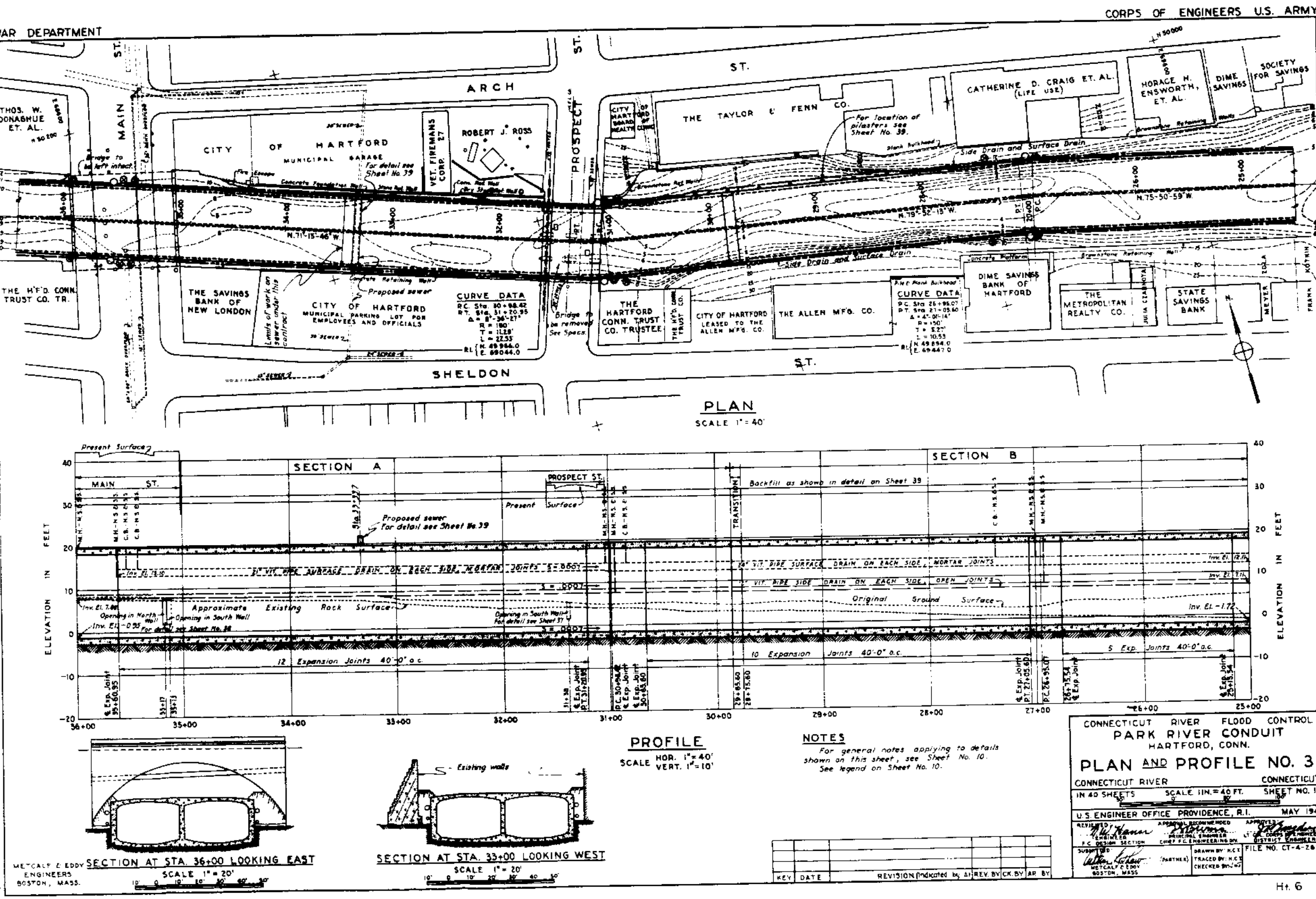
SUBMITTED: METCALF & EDDY, BOSTON, MASS. (PARTNER)

DRAWN BY H.C.T. TRACED BY H.C.T. CHECKED BY

FILE NO. CT-4-2609

H+ 6

PLATE NO. 3

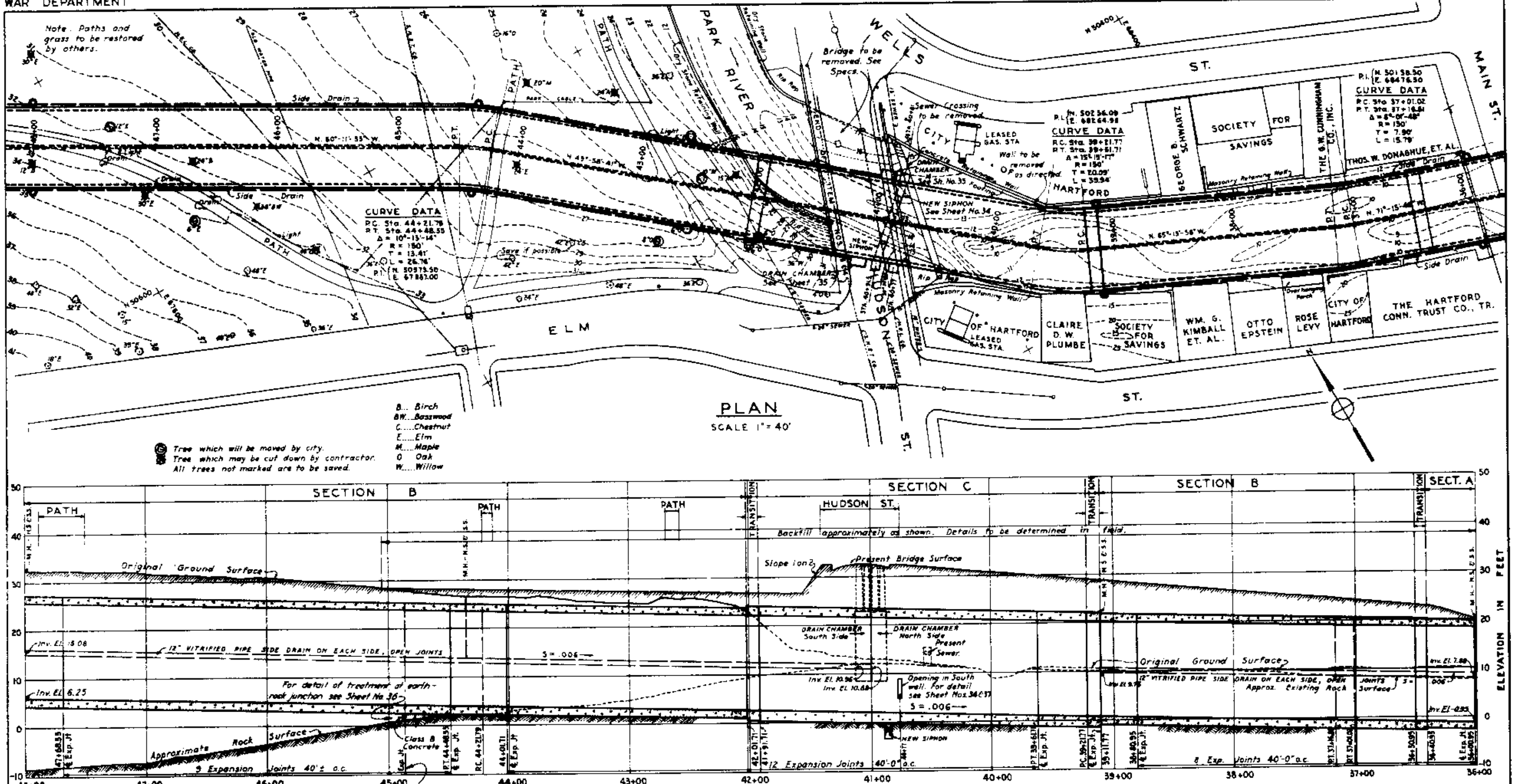


WAR DEPARTMENT
CORPS OF ENGINEERS U.S. ARMY
ARCH ST.
MAIN ST.
PROSPECT ST.
SHELDON ST.
THOS. W. DONAGHUE ET. AL.
CITY OF HARTFORD MUNICIPAL GARAGE
For detail see Sheet No. 39
VET. FIREMANS CORP. 27
ROBERT J. ROSS
CITY HARTFORD BOARD OF HEALTH
THE TAYLOR & FENN CO.
For location of pilasters see Sheet No. 39.
CATHERINE D. CRAIG ET. AL. (LIFE USE)
HORACE H. ENSWORTH, ET. AL.
DIME SAVINGS
SOCIETY FOR SAVINGS
Side Drain and Surface Drain
N. 71°-15'-46" W.
N. 79°-52'-13" W.
N. 75°-50-59" W.
THE H'F'D. CONN. TRUST CO. TR.
THE SAVINGS BANK OF NEW LONDON
Limits of work on sewer under this contract
Proposed sewer
CITY OF HARTFORD MUNICIPAL PARKING LOT FOR EMPLOYEES AND OFFICIALS
CURVE DATA
P.C. Sta. 30+98.42
P.T. Sta. 31+20.95
Δ = 8°-36'-27"
R = 150'
T = 11.28'
L = 22.53'
Bridge to be removed See Specs.
THE HARTFORD CONN. TRUST CO. TRUSTEE
THE H'F'D. CONN. TRUST CO.
CITY OF HARTFORD LEASED TO THE ALLEN M'F'G. CO.
THE ALLEN M'F'G. CO.
CURVE DATA
P.C. Sta. 26+95.07
P.T. Sta. 27+05.60
R = 150'
DIME SAVINGS BANK OF HARTFORD
THE METROPOLITAN REALTY CO.
JULIA CZARNOTA
STATE SAVINGS BANK
MEYER
FRANK KOTKIN
PLAN
SCALE 1" = 40'
Present Surface
SECTION A
SECTION B
MAIN ST.
PROSPECT ST.
Proposed sewer For detail see Sheet No. 39
TRANSITION
Backfill as shown in detail on Sheet 39
21" VIT. PIPE SURFACE DRAIN ON EACH SIDE, MORTAR JOINTS S = .0007
24" VIT. PIPE SURFACE DRAIN ON EACH SIDE, MORTAR JOINTS
VIT. PIPE SIDE DRAIN ON EACH SIDE, OPEN JOINTS
Approximate Existing Rock Surface
Original Ground Surface
Opening in North Wall
Opening in South Wall For detail see Sheet No. 38
Opening in South Wall For detail see Sheet 37
Inv. El. -1.72
12 Expansion Joints 40'-0" o.c.
10 Expansion Joints 40'-0" o.c.
5 Exp. Joints 40'-0" o.c.
ELEVATION IN FEET
36+00 35+00 34+00 33+00 32+00 31+00 30+00 29+00 28+00 27+00 26+00 25+00
PROFILE
SCALE HOR. 1" = 40' VERT. 1" = 10'
NOTES
For general notes applying to details shown on this sheet, see Sheet No. 10.
See legend on Sheet No. 10.
Existing walls
SECTION AT STA. 36+00 LOOKING EAST
SCALE 1" = 20'
SECTION AT STA. 33+00 LOOKING WEST
SCALE 1" = 20'
METCALF & EDDY ENGINEERS BOSTON, MASS.
KEY DATE REVISION (Indicated by Δ) REV. BY CK. BY AP. BY
CONNECTICUT RIVER FLOOD CONTROL
PARK RIVER CONDUIT
HARTFORD, CONN.
PLAN AND PROFILE NO. 3
CONNECTICUT RIVER CONNECTICUT
IN 40 SHEETS SCALE 1 IN. = 40 FT. SHEET NO. 12
U.S. ENGINEER OFFICE PROVIDENCE, R.I. MAY 1940
FILE NO. CT-4-2610
Ht. 6

PLATE NO. 4

WAR DEPARTMENT

CORPS OF ENGINEERS U.S. ARMY



Exact location of expansion joint to be determined in field.

NOTES

For general notes applying to details shown on this sheet, see Sheet No. 10.

See legend on Sheet No. 10.

Leave opening for discharge pipe from proposed pumping station. Location and size to be determined later. For details see Sheet No. 37.

PROFILE

SCALE HOR. 1" = 40' VERT. 1" = 10'

KEY	DATE	REV S ON (Indicated by Δ)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

PLAN AND PROFILE NO. 4

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE 1 IN. = 40 FT. — SHEET NO. 13

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

REVIEWED: ENGINEER F.C. DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER CHIEF F.C. ENGINEERING DIV. — APPROVED: LT. COL. CORPS OF ENGINEERS DISTRICT ENGINEER

SUBMITTED: (PARTNER) METCALF & EDDY BOSTON, MASS. — DRAWN BY: H.C.T. TRACED BY: H.C.T. CHECKED BY: — FILE NO. CT-4-2611

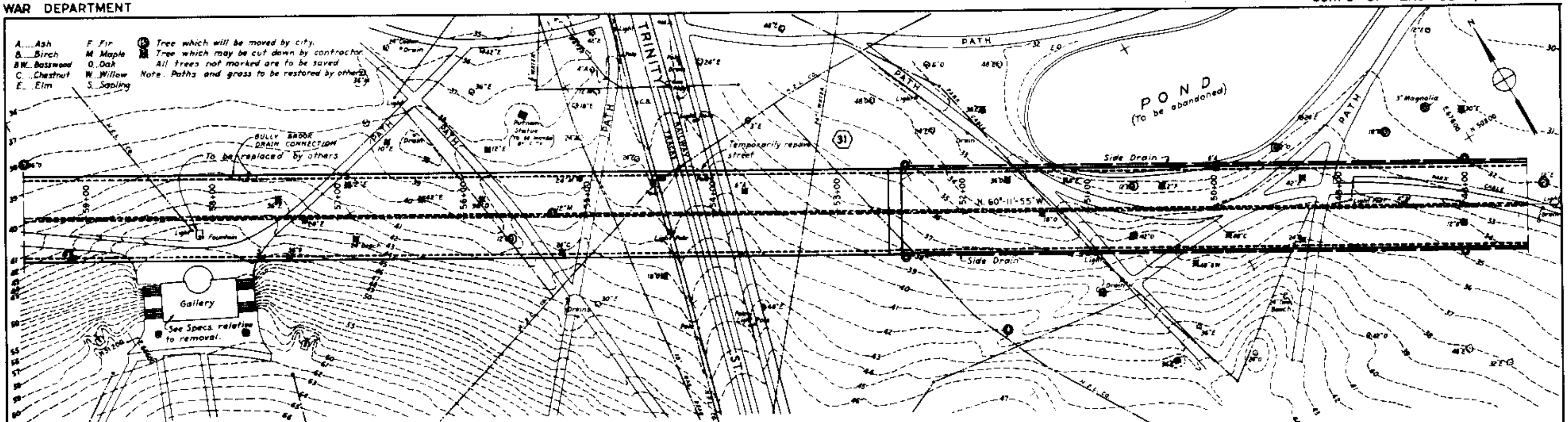
METCALF & EDDY ENGINEERS BOSTON, MASS.

PLATE NO. 5

Ht. 6

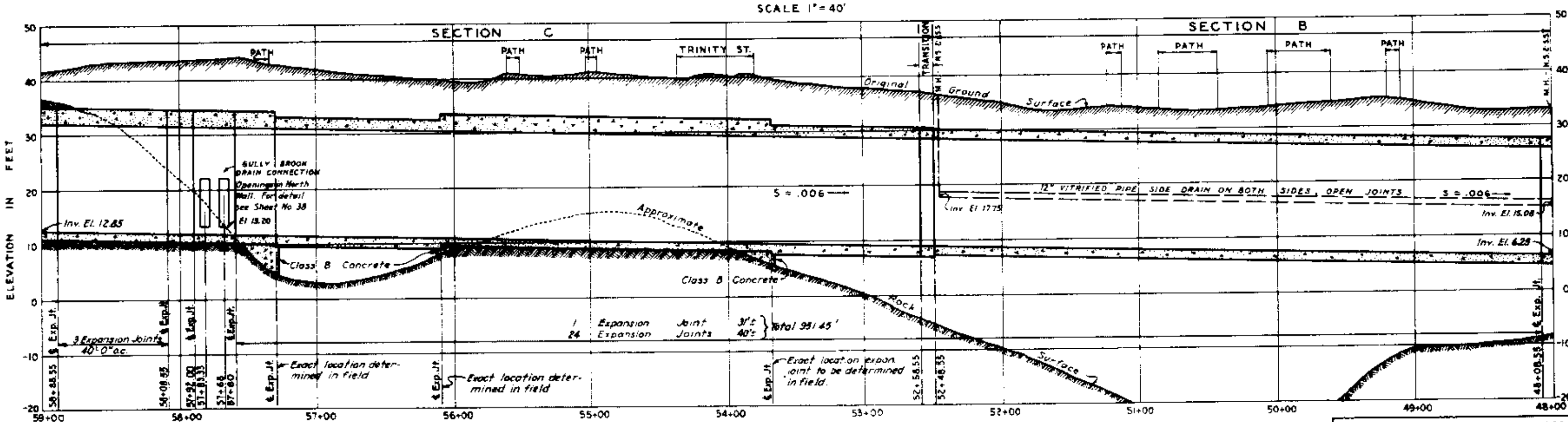
WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



PLAN

SCALE 1" = 40'



NOTES

For general notes applying to details shown on this sheet, see Sheet No. 10.
See legend on Sheet No. 10.
For detail of treatment at earth-rock junction see Sheet No. 36.

PROFILE

SCALE HOR. 1" = 40' VERT. 1" = 10'

KEY	DATE	REVISION (indicated by A)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

PLAN AND PROFILE NO. 5

CONNECTICUT RIVER CONNECTICUT

IN 40 SHEETS SCALE 1 IN. = 40 FT. SHEET NO. 14

U.S. ENGINEER OFFICE PROVIDENCE, R.I. MAY 1940

REVIEWED: ENGINEER F.C. DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER CHIEF F.C. ENGINEERING DIV. — APPROVED: LT. COL. CORPS OF ENGINEERS DISTRICT ENGINEER

SUBMITTED: METCALF & EDDY BOSTON, MASS. (PARTNER) — DRAWN BY H.C.T. TRACED BY H.C.T. CHECKED BY P.&J. — FILE NO. CT-4-2612

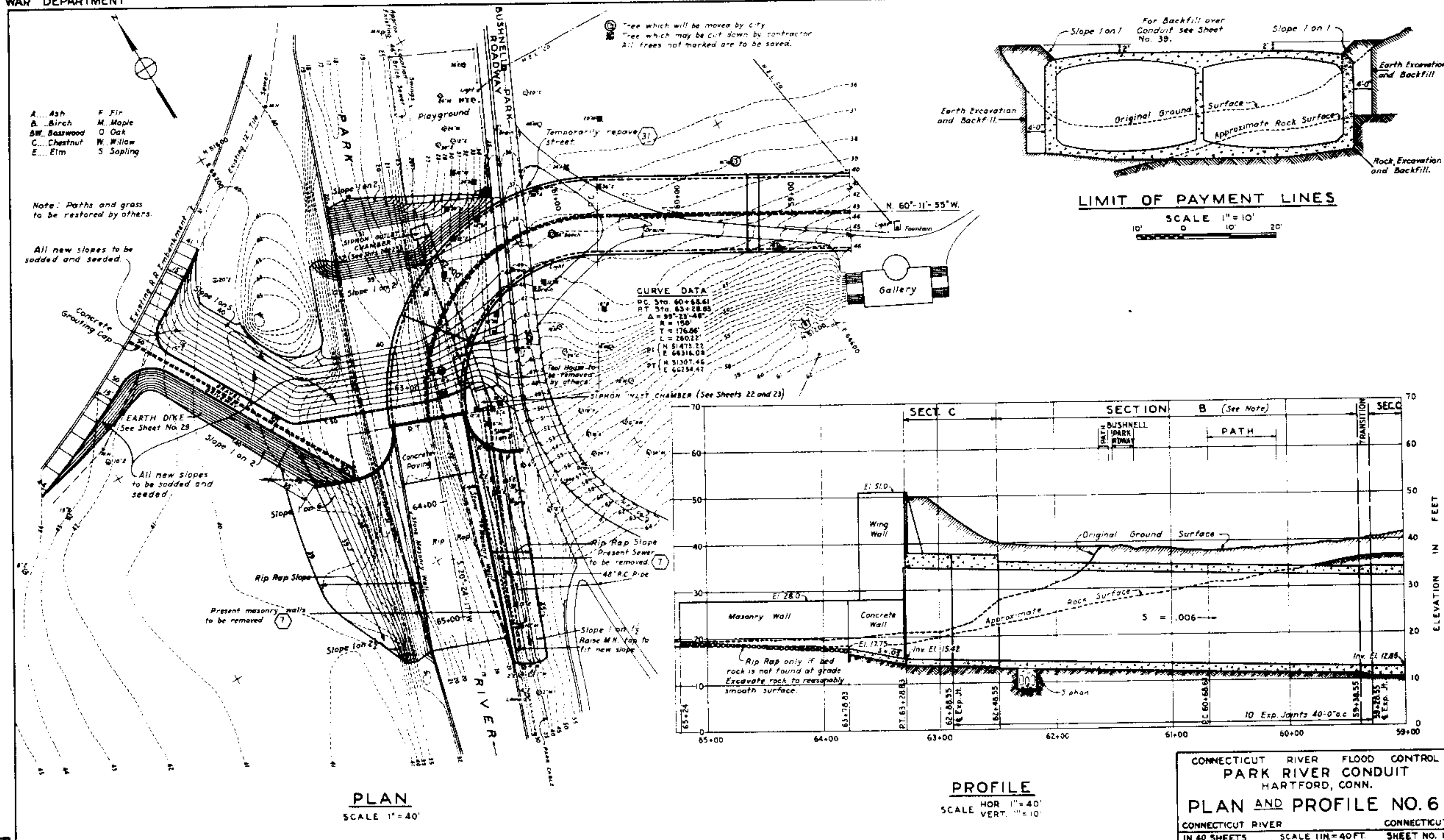
METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PLATE NO. 6

Ht. 6

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



NOTES

For general notes applying to details shown on this sheet, see Sheet No. 10.

See legend on Sheet No. 10.

The center wall of Section B between Stations 59+38.55 and 62+48.55 is to be 24" thick instead of 22".

Radius of curves and details of inlet may be modified as the result of pending model tests.

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

KEY	DATE	REVISION (indicated by Δ)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL
PARK RIVER CONDUIT
HARTFORD, CONN.

PLAN AND PROFILE NO. 6

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE 1 IN. = 40 FT. — SHEET NO. 15

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

REVIEWED: ENGINEER F.C. DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER CHIEF F.C. ENGINEERING DIV. — APPROVED: DISTRICT ENGINEER

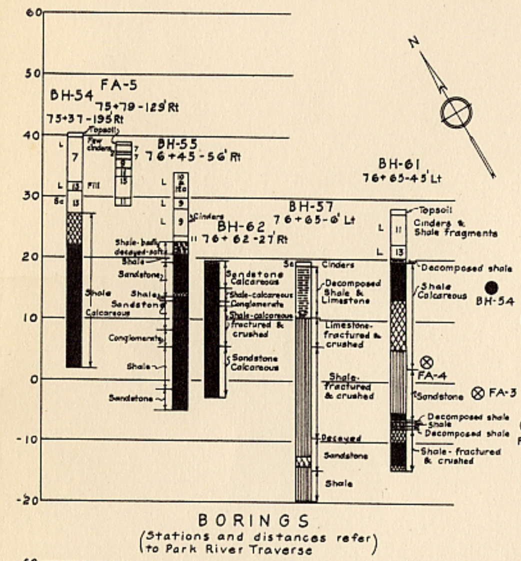
SUBMITTED: METCALF & EDDY BOSTON, MASS (PARTNER) — DRAWN BY H.C.T. — TRACED BY H.C.T. — CHECKED BY — FILE NO. CT-4-2619

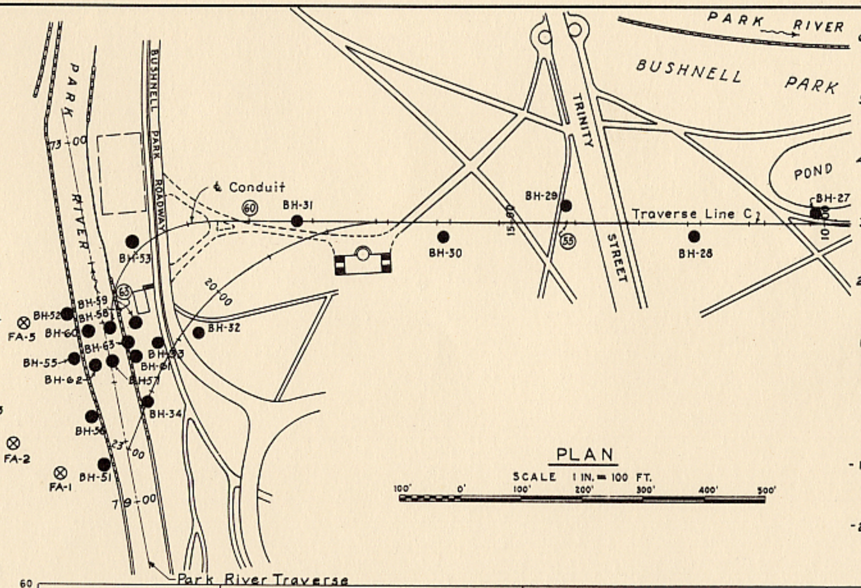
PLATE NO. 7

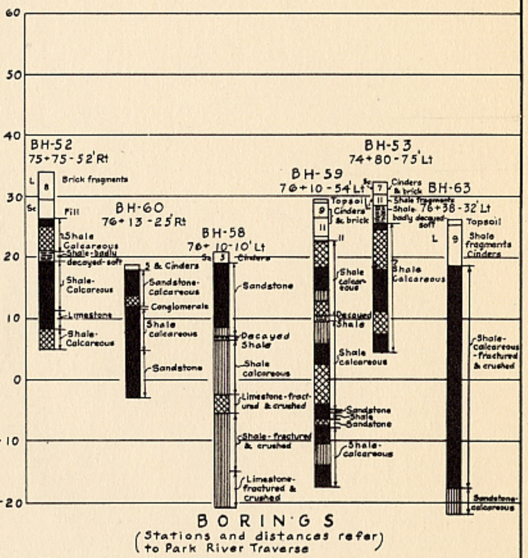
Ht. 6

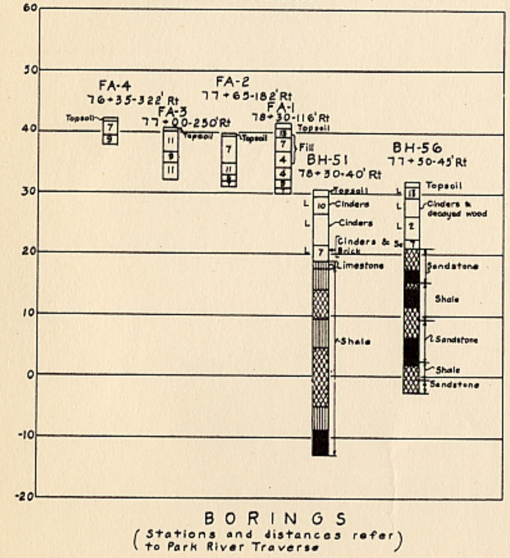
WAR DEPARTMENT

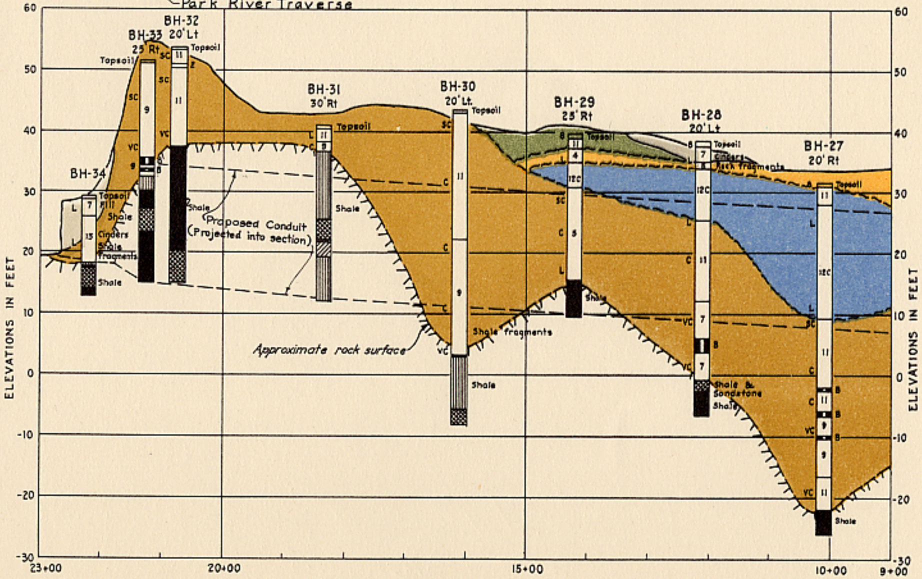
CORPS OF ENGINEERS, U.S. ARMY











BORINGS

(Stations are not the same as the stations of the ℄ of the conduit.)

PROFILE ALONG TRAVERSE LINE C

NOTES:

For general notes, legend and description of soil classes, see "Subsurface Explorations No. 2."

⊗ FA indicates foundation auger boring.

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

SUBSURFACE EXPLORATIONS NO. 4

CONNECTICUT RIVER CONNECTICUT

IN 40 SHEETS SCALE 1" = 100' SHEET NO. 8

U.S. ENGINEER OFFICE PROVIDENCE, R.I. MAY 1940

REVIEWED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF F.C. ENGINEERING DIV.

APPROVED: COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

SUBMITTED: (PARTNER) METCALF & EDDY, BOSTON, MASS.

DRAWN BY: E.S.S. TRACED BY: E.S.S. CHECKED BY: P.W.T.

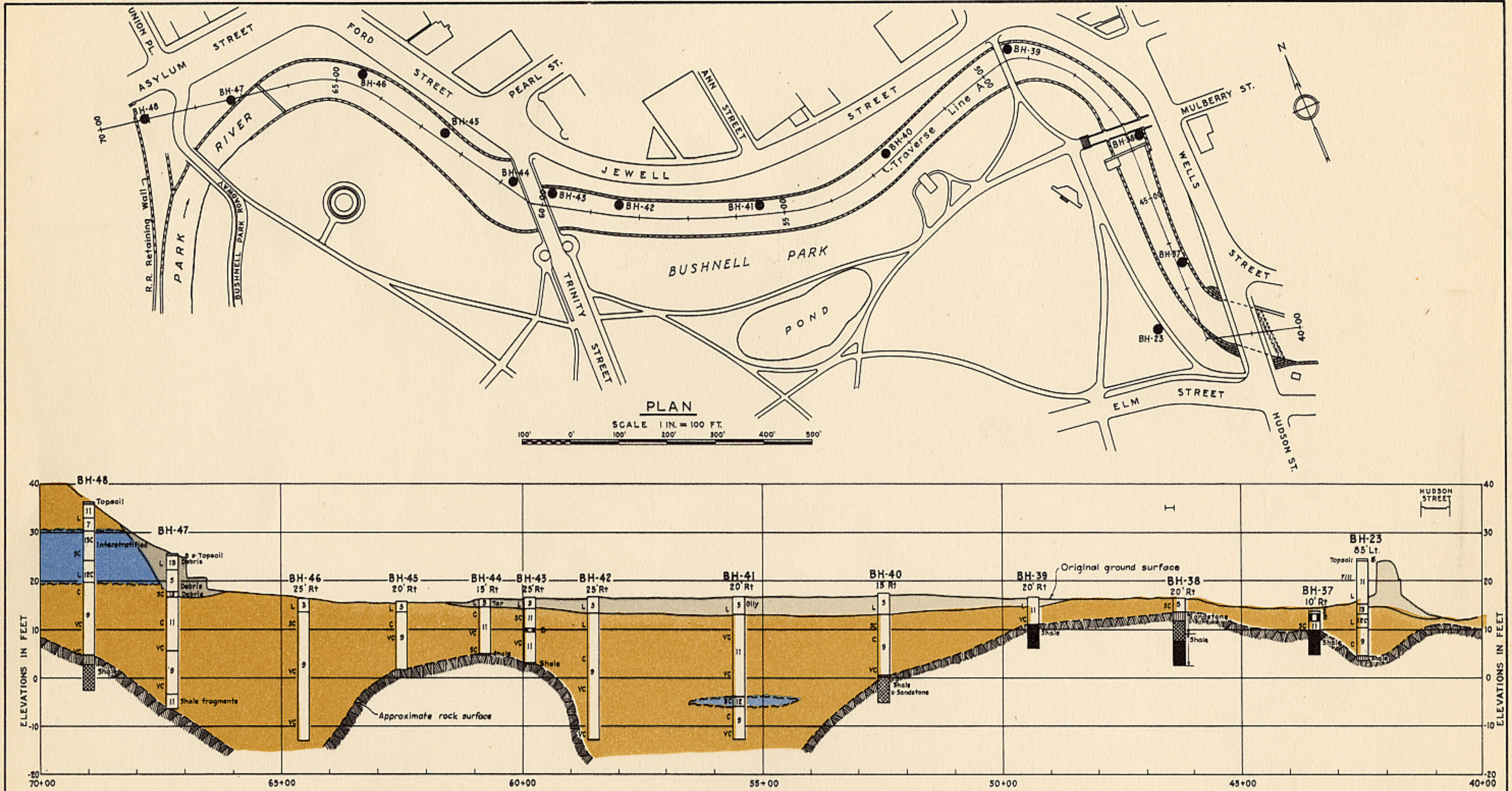
FILE NO. CT-2-1289

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PLATE NO. 11

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



BORINGS

PROFILE ALONG TRAVERSE LINE A

(Stations are not the same as the stations of the ℄ of the conduit.)

NOTES:

For general notes, legend and description of soil classes see "Subsurface Explorations No. 2."

Elevations refer to Mean Sea Level Datum

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AR. BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

SUBSURFACE EXPLORATIONS NO. 3

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE 1" = 100' — SHEET NO. 7

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

REVIEWED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF P.G. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

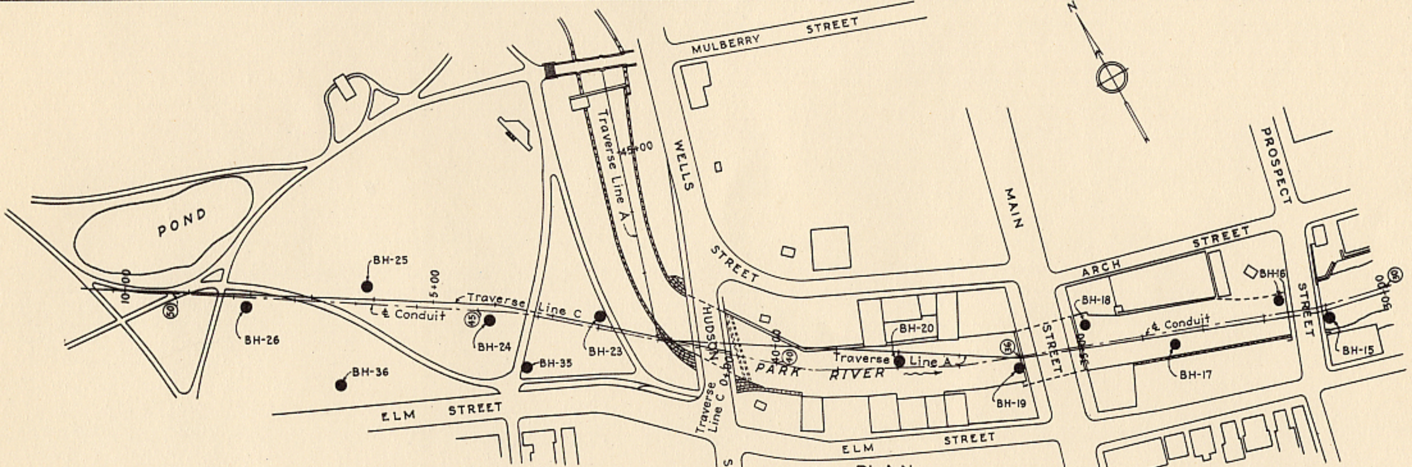
SUBMITTED: (PARTNER) METCALF & EDDY, BOSTON, MASS.

DRAWN BY: — TRACED BY: — CHECKED BY: — FILE NO. CT-2-1288

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

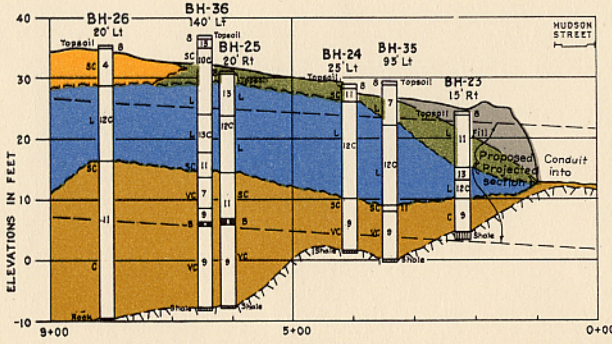
PLATE NO. 10

Ht. 6

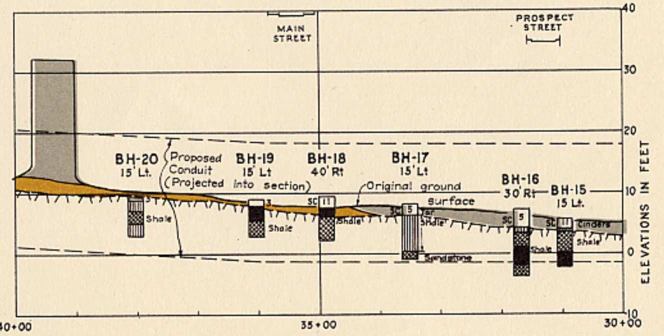


PLAN

SCALE 1 IN. = 100 FT.



PROFILE ALONG TRAVERSE LINE C



PROFILE ALONG TRAVERSE LINE A

LEGEND

- L Loose material
- SC Slightly compact material
- C Compact material
- VC Very compact material
- Rt Right of traverse line
- Lt Left of traverse line
- BH- Drive Sample Bore Hole
- Boulder.
- Weathered & fractured bedrock Core recovery less than 50%
- Less weathered & fractured bed rock Core recovery between 50% & 75%
- Relatively unweathered bedrock Core recovery more than 75%
- Artificial fill-cinders, ashes, debris, etc.
- Pervious material-sand or gravel and sand.
- Moderately impervious material- silt and sand or mixed silt, sand, and gravel.
- Impervious material- varved clay
- Hardpan-gravel, sand, and silt mixture.
- Impervious material- silt with some sand and clay. (Alluvial deposits)

BORINGS

PROFILES ALONG TRAVERSE LINES

(Stations are not the same as the stations of the ℄ of the conduit.)

DESCRIPTION OF SOIL CLASSES

1 Graded from Gravel to Coarse Sand - contains little medium sand.

2 Coarse to Medium Sand - contains little gravel and fine sand.

3 Graded from Gravel to Medium Sand - contains little fine sand.

4 Medium to Fine Sand - contains little coarse sand and coarse silt.

5 Graded from Gravel to Fine Sand - contains little coarse silt.

6 Fine Sand to Coarse Silt - contains little medium sand and medium silt.

7 Graded from Gravel to Coarse Silt.- contains little medium silt.

8 Coarse to Medium Silt - contains little fine sand and fine silt.

9 Graded from Gravel to Medium Silt - contains little fine silt.

10 Medium to Fine Silt - contains little coarse silt and coarse clay. Possesses behaviour characteristics of silt.

10C Medium Silt to Coarse Clay - contains little coarse silt and medium clay. Possesses behaviour characteristics of clay.

11 Graded from Gravel or Coarse Sand to Fine Silt - contains little coarse clay.

12 Fine Silt to Clay - contains little medium silt and fine clay (colloids). Possesses behaviour characteristics of silt.

12C Clay- contains little silt. Possesses behaviour characteristics of clay.

13 Graded from Coarse Sand to Clay.- contains little fine clay (colloids). Possesses behaviour characteristics of silt.

13C Clay.- Graded from sand to fine clay (colloids). Possesses behaviour characteristics of clay.

NOTES

The logs, samples and test results pertaining to these investigations may be inspected at the United States Engineer Office in Providence, Rhode Island.

Classes 10 and 12c indicated in bore hole records generally occur in alternating bands, having thin layers of fine clay interbedded with thicker layers of silt.

Topography traced from photostatic reductions of maps made for the Hartford Flood Investigation and Improvement Commission by the City of Hartford Engineering Dept.

All bore holes, except BH-1A and BH-3A, were driven using 2½ inch casing, recovering ½ inch soil samples at less than 5 foot intervals. Bore holes BH-1A and BH-3A were driven using 6 inch casing, recovering undisturbed soil samples of 4½ inch diam. of the underlying clay stratum.

Compactness was determined by the number of blows required to drive 2" O.D. sample spoon one foot with 300 pound hammer dropped 18".

Elevations refer to Mean Sea Level Datum.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

SUBSURFACE EXPLORATIONS NO. 2

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE 1" = 100' — SHEET NO. 6

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

REVIEWED: [signature] SENIOR GEOLOGIST HEAD, GEOLOGY SECTION

APPROVAL RECOMMENDED: [signature] PRINCIPAL ENGINEER CHIEF F.C. ENGINEERING DIV.

APPROVED: [signature] COL. CORPS OF ENGINEERS DISTRICT ENGINEER

SUBMITTED: [signature] (PARTNER) METCALF & EDDY BOSTON, MASS.

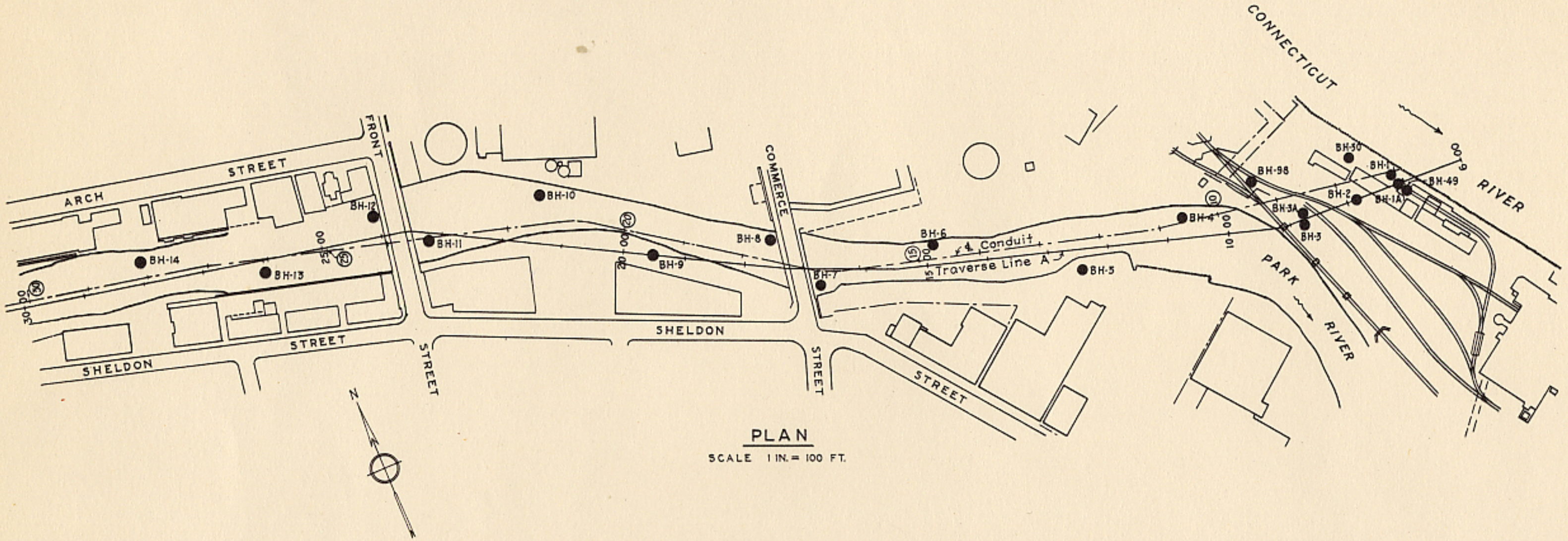
DRAWN BY: E.S.S. TRACED BY: E.S.S. H.C.T. CHECKED BY: RMT

FILE NO. CT.-2-1287

METCALF & EDDY, ENGINEERS, BOSTON, MASS.

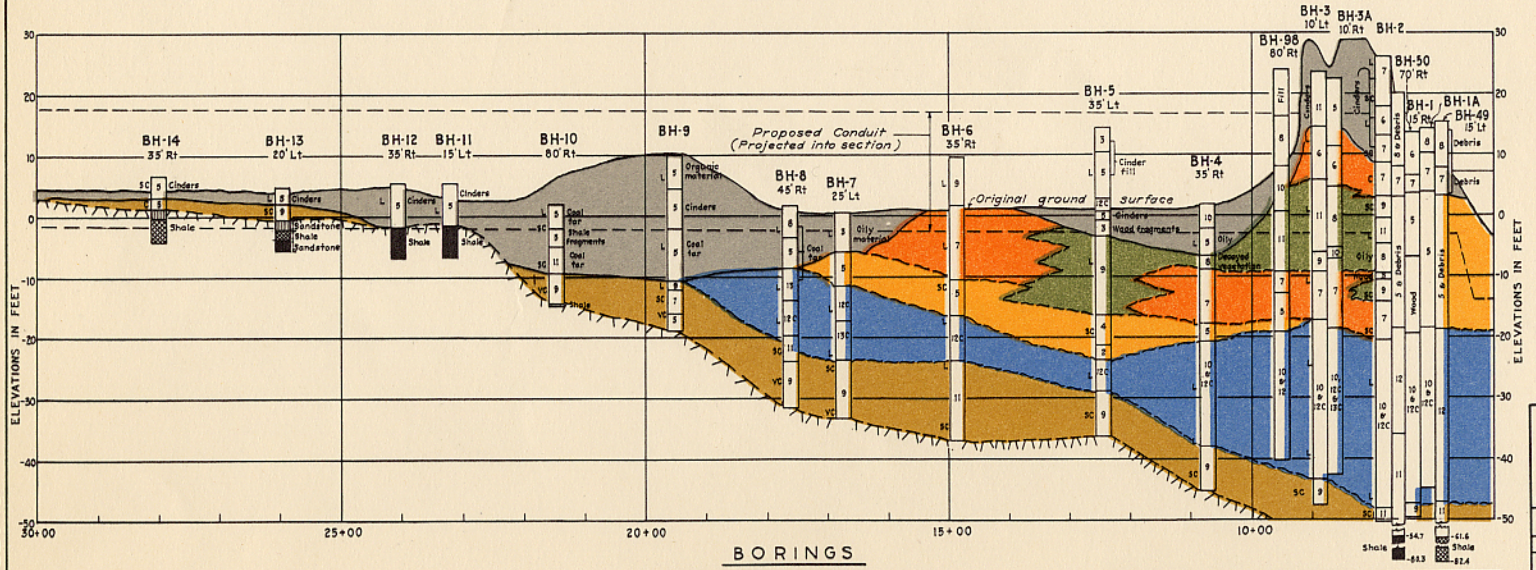
WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



PLAN

SCALE 1 IN. = 100 FT.



BORINGS

PROFILE ALONG TRAVERSE LINE A

(Stations are not the same as the stations of the ℄ of the conduit.)

NOTES:

For general notes, legend and description of soil classes, see "Subsurface Explorations No. 2".

Classes 10 and 12c indicated in bore hole records generally occur in alternating bands, having thin layers of fine clay interbedded with thicker layers of silt.

Elevations refer to Mean Sea Level Datum

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CK. BY	AP. BY

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT
HARTFORD, CONN.

SUBSURFACE EXPLORATIONS NO. 1

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE 1" = 100' — SHEET NO. 5

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

REVIEWED: Senior Geologist, Head, Geology Section
APPROVAL RECOMMENDED: Principal Engineer, Chief F.C. Engineering Div.
APPROVED: Lt. Col., Corps of Engineers, District Engineer

SUBMITTED: (PARTNER) METCALF & EDDY BOSTON, MASS.

DRAWN BY: E.S.B. TRACED BY: E.S.B. H.C.T. CHECKED BY: R.W.T.

FILE NO. CT-2-1286

PLATE NO. 8

Ht. 6

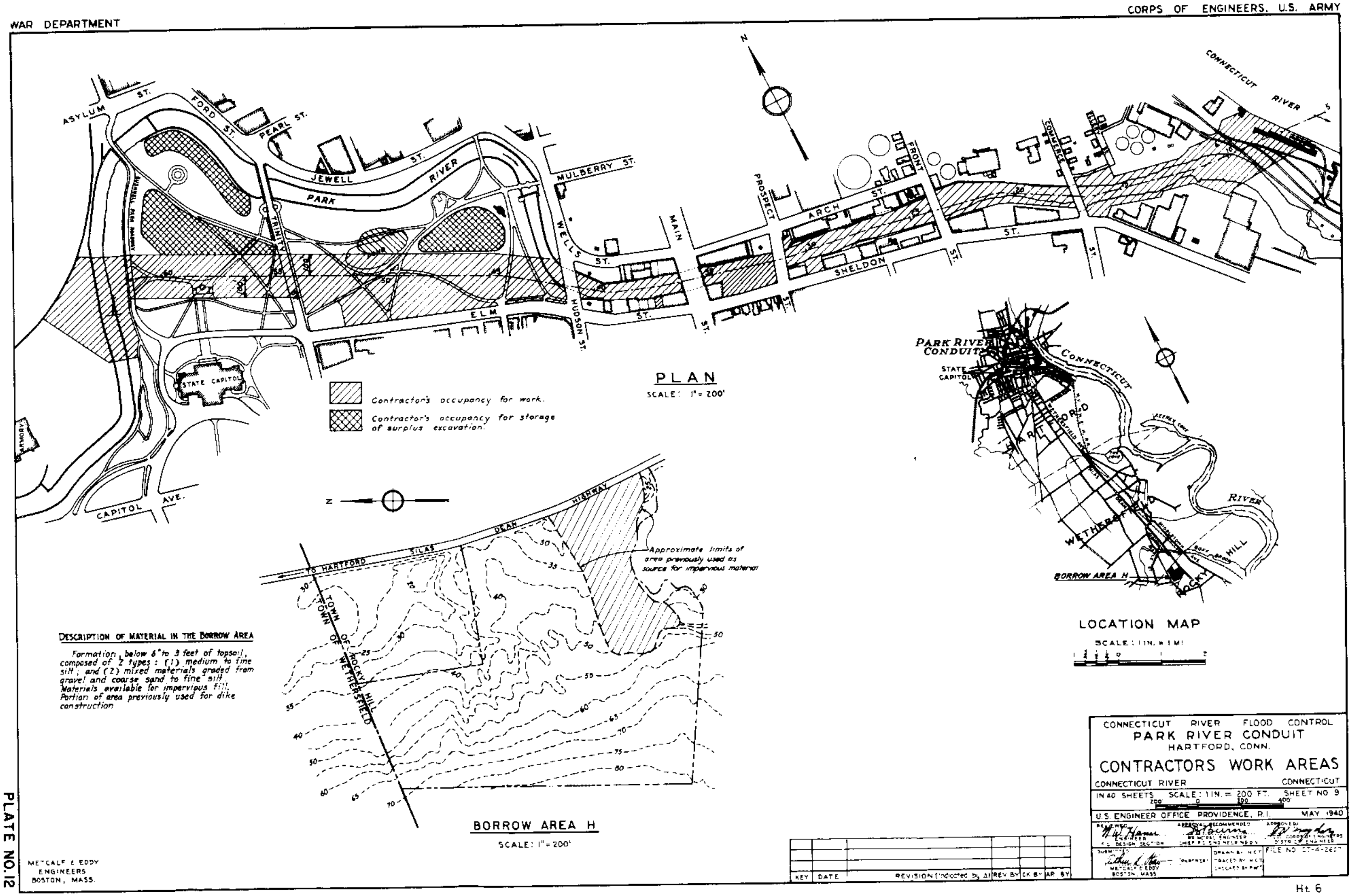


PLATE NO. 12

Ht. 6

PROVIDENCE DISTRICT SOIL CLASSIFICATION

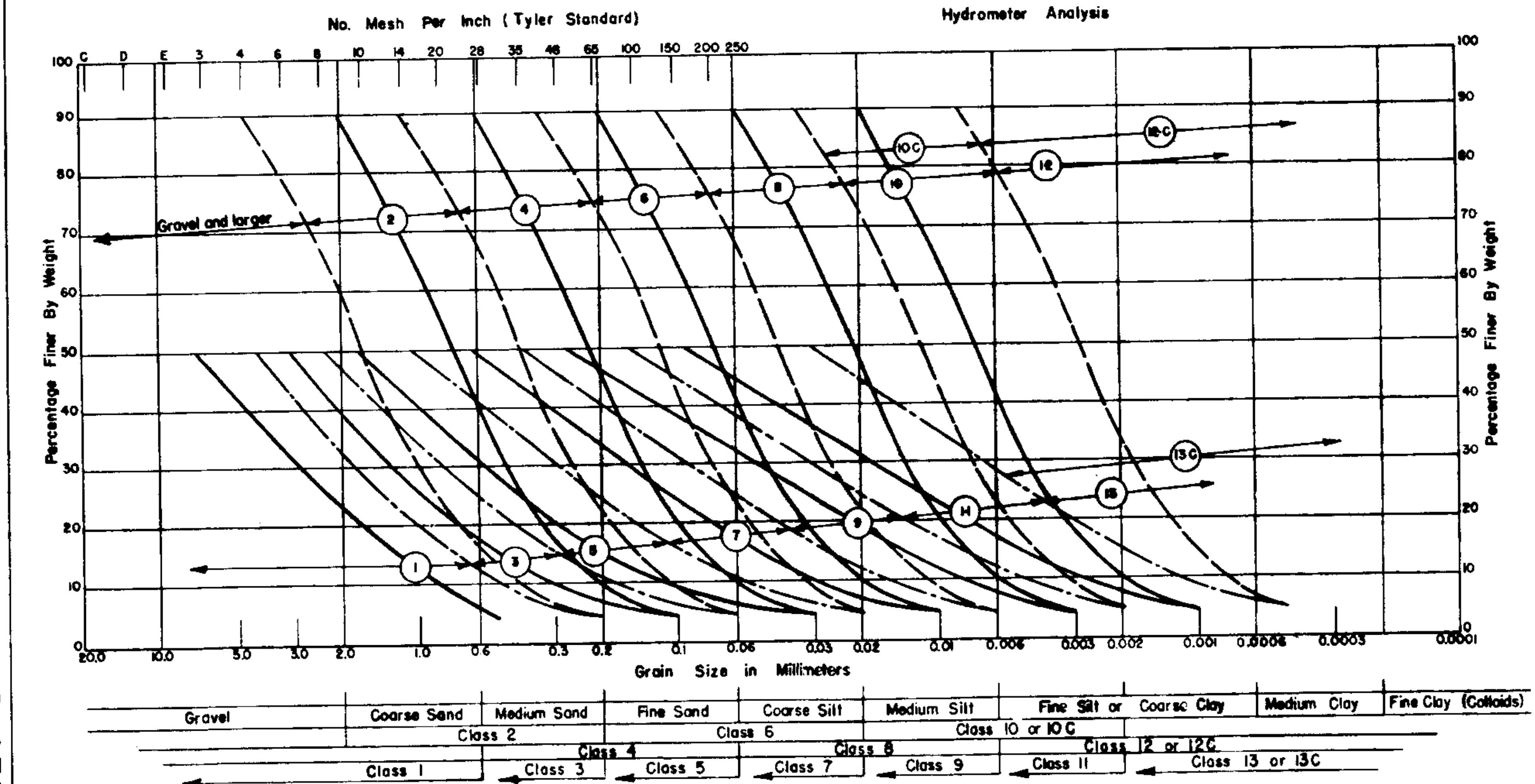
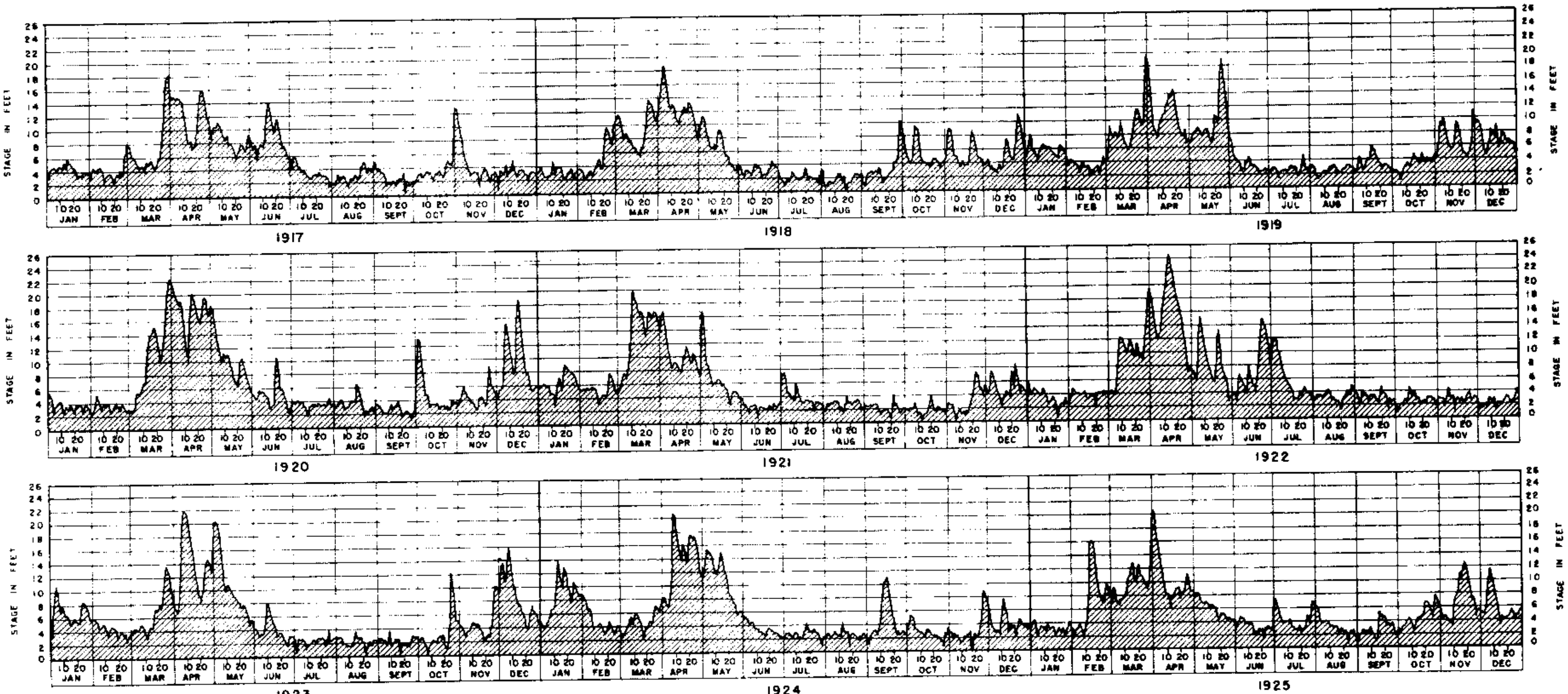


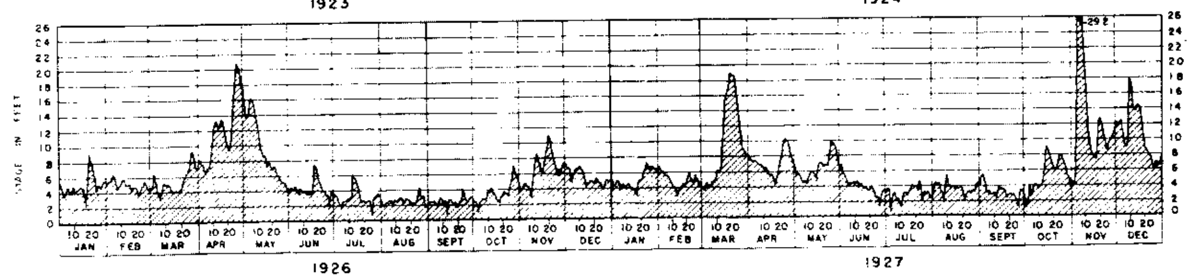
DIAGRAM SHOWING LIMITS OF SOIL CLASSES

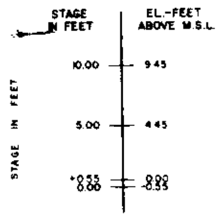
PLATE NO.13

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY.







STAGE-ELEVATION RELATION

NOTES:

Low stages are subject to tidal fluctuation which has a mean amplitude 0 at a stage of 7 feet and 1.5 feet at a stage of 2 feet.

Stage readings on Hartford gage, zero = -0.55 M.S.L.

Data supplied by U.S. Weather Bureau.

Gage located on downstream side of Memorial Bridge (Connecticut Boulevard).

KEY	DATE	REVISION (indicated by Δ)	REV.BY	CK.BY	AP.BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

HYDROGRAPH NO. 1 - CONNECTICUT RIVER

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE AS SHOWN — SHEET NO. 2

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., MAY, 1940

SUBMITTED: ENGINEER, HEAD, HYDRAULICS SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV. — APPROVED: DISTRICT ENGINEER

COMPILED: — DRAWN BY: — TRACED BY: — CHECKED BY:

FISCAL YEAR 1940

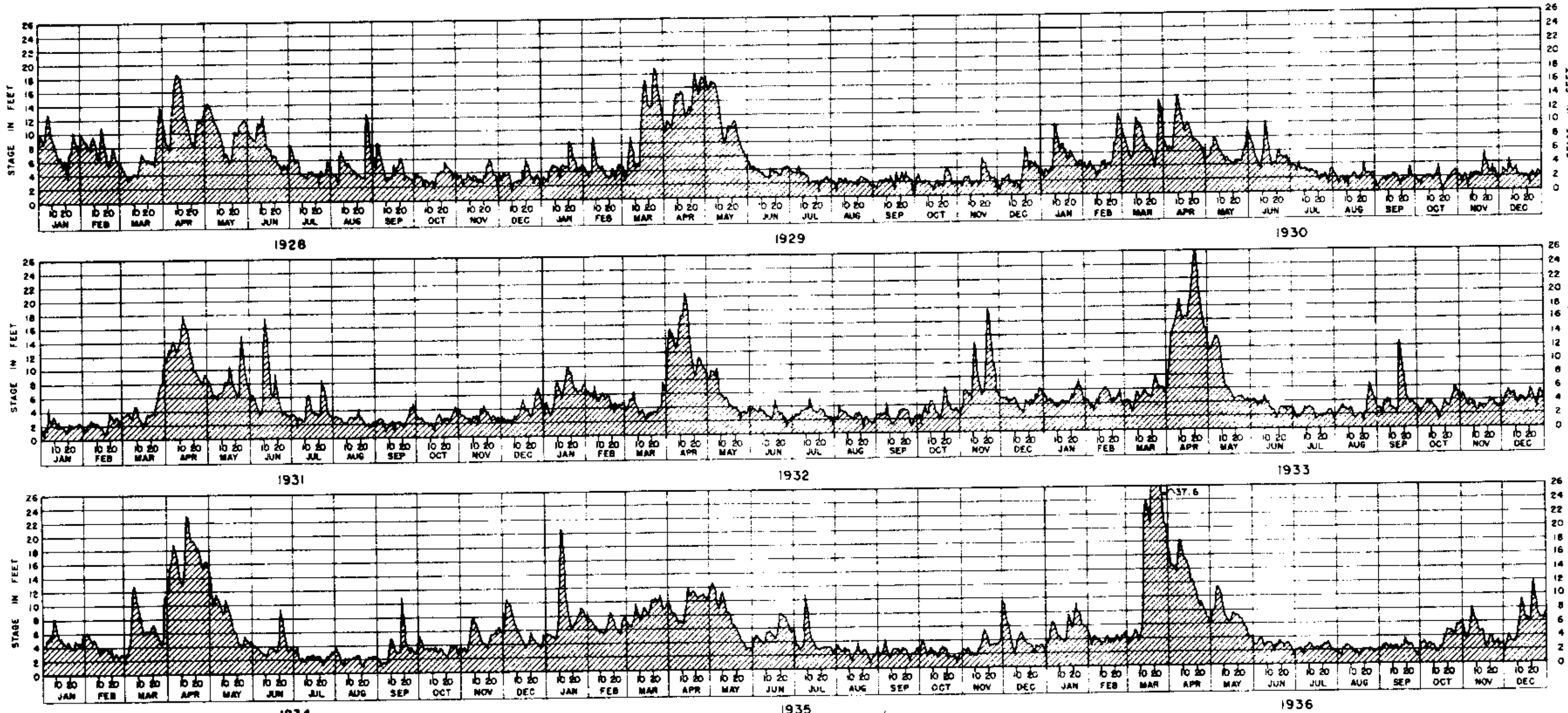
FILE NO. CT-3-1174

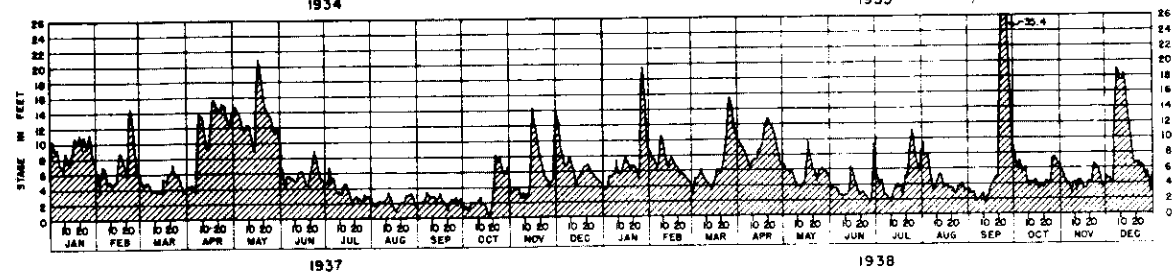
Ht. 6

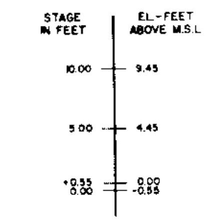
PLATE NO. 14

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY







STAGE-ELEVATION RELATION

NOTES:

Low stages are subject to tidal fluctuation which has a mean amplitude 0 at a stage of 7 feet and 1.5 feet at a stage of 2 feet.

Stage readings on Hartford gage, zero=-0.55' M S L

Data supplied by U. S. Weather Bureau

Gage located on downstream side of Memorial Bridge (Connecticut Boulevard)

KEY	DATE	REVISION (indicated by Δ)	REV. BY	CK BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

PARK RIVER CONDUIT

HARTFORD, CONN.

HYDROGRAPH NO. 2-CONNECTICUT RIVER

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SCALE AS SHOWN — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R.I., MAY 1940

SUBMITTED: ENGINEER, HEAD, HYDRAULICS SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV. — APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

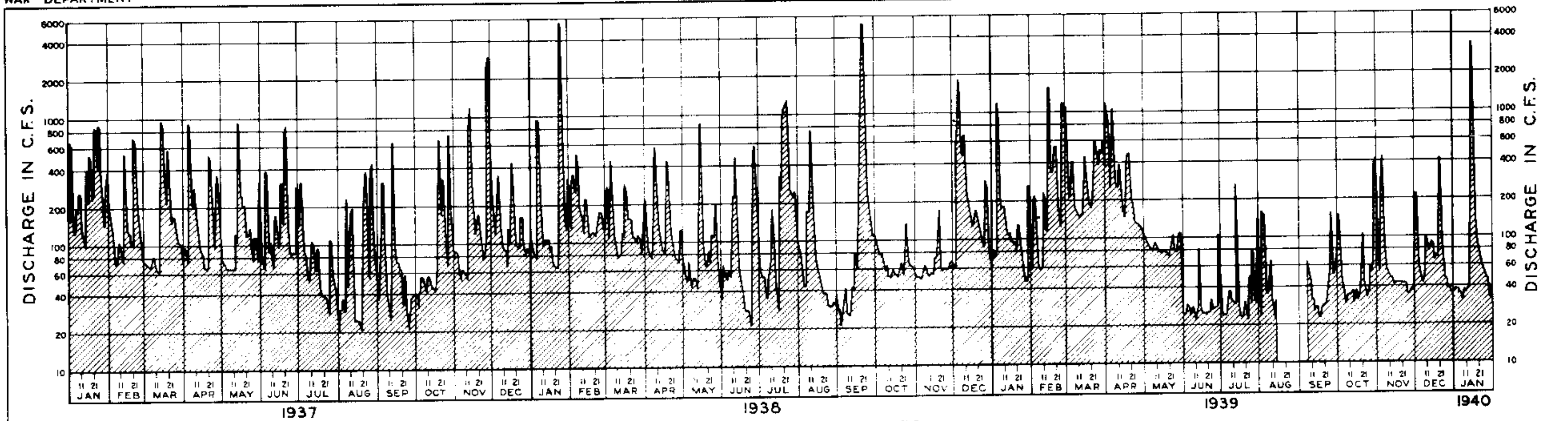
COMPILED: ASSOC. ENGINEER — DRAWN BY: W.W.V. & F.C.T. TRACED BY: W.W.R. CHECKED BY: — FISCAL YEAR 1940 FILE NO. CT-3-1175

Ht. 6

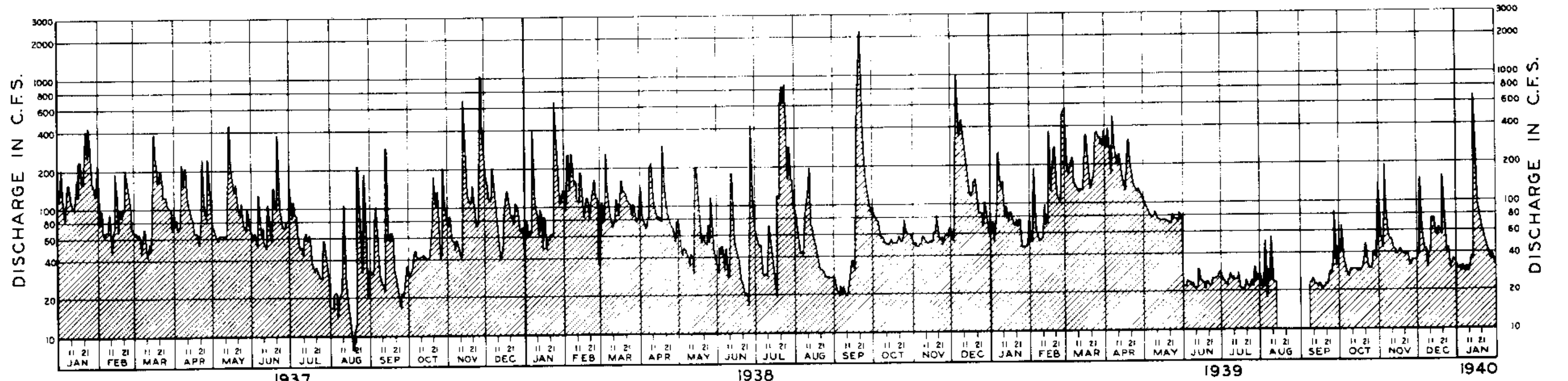
PLATE NO. 15

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



DAILY MAXIMUM DISCHARGES



DAILY MINIMUM DISCHARGES

NOTES

Daily maximum and minimum discharges are computed from readings taken at Riverside St.

Data for this sheet furnished by the Department of Engineering of the City of Hartford, Conn.

Drainage areas :-

At gaging station of Riverside St. just below junction of North and South Branches = ... 74.0 Sq. Mi.

At inlet of proposed conduit = ... 75.2 " "

At junction of Park River and Conn. River = 77.8 " "

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

KEY	DATE	REVISION (indicated by ⚠)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL
PARK RIVER CONDUIT
HARTFORD, CONN.

HYDROGRAPH — PARK RIVER

CONNECTICUT RIVER — CONNECTICUT

IN 40 SHEETS — SHEET NO. 4

U.S. ENGINEER OFFICE PROVIDENCE, R.I. — MAY 1940

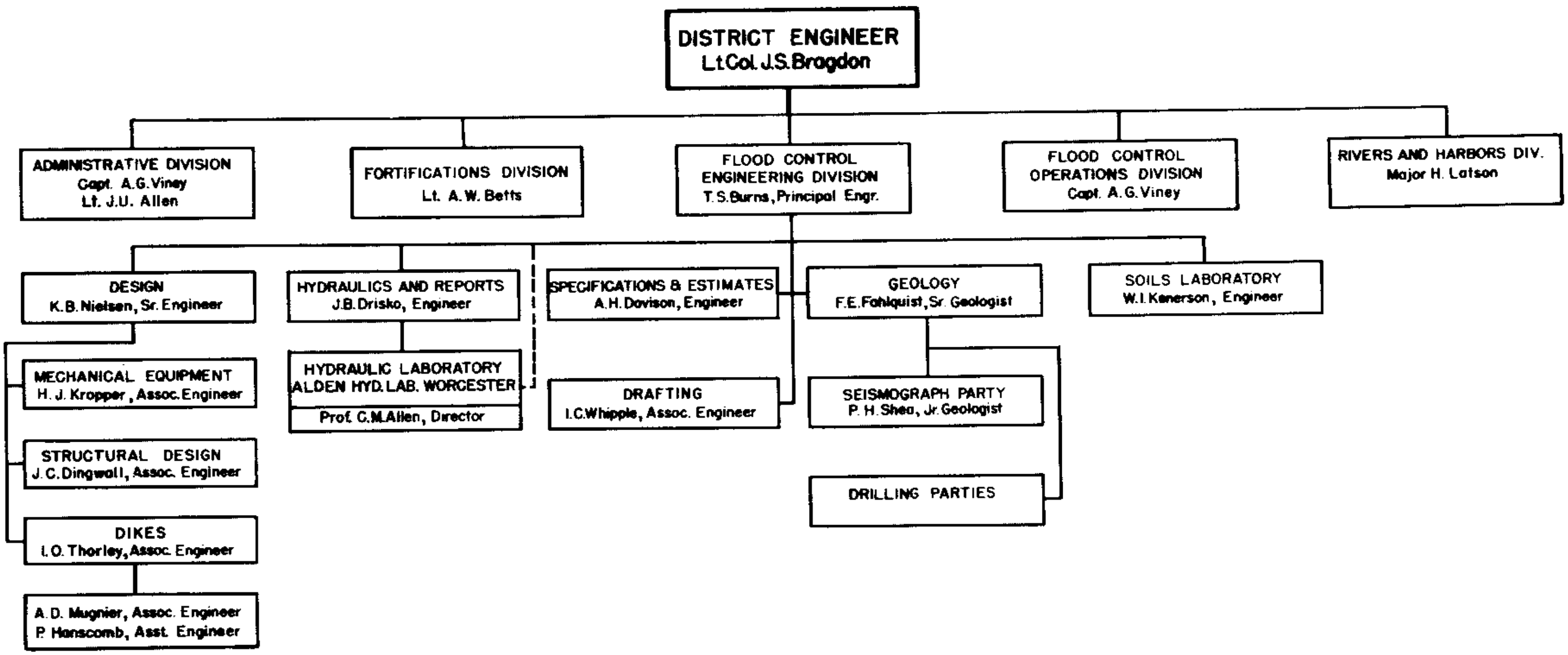
REVIEWED: ENGINEER, HEAD, HYDRAULICS SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF F.C. ENGINEERING DIV. — APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

SUBMITTED (PARTNER) METCALF & EDDY, BOSTON, MASS. — DRAWN BY H.C.T. TRACED BY H.C.T. CHECKED BY P&S — FILE NO. CT.-3-1173

PLATE NO. 16

Ht. 6

PLATE NO. 17



ORGANIZATION CHART

FLOOD CONTROL

ENGINEERING DIVISION

U.S. ENGINEER OFFICE, PROVIDENCE, R.I.

SEPT. 25, 1940